Report from the Healthy and Biologically Diverse Seas Evidence Group (HBDSEG) Workshop

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The potential use of mapped extent and distribution of habitats as indicators of Good Environmental Status (GES)

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Executive Summary

The Healthy and Biologically Diverse Seas Evidence Group (HBDSEG) has been tasked with providing the technical advice for the implementation of the Marine Strategy Framework Directive (MSFD) with respect to descriptors linked to biodiversity. A workshop was held in London to address one of the Research and Development (R&D) proposals entitled: *'Mapping the extent and distribution of habitats using acoustic and remote techniques, relevant to indicators for area/extent/habitat loss.'* The aim of the workshop was to identify, define and assess the feasibility of potential indicators of benthic habitat distribution and extent, and identify the R&D work which could be required to fully develop these indicators.

The main points that came out of the workshop were:

(i) There are many technical aspects of marine habitat mapping that still need to be resolved if cost-effective spatial indicators are to be developed. Many of the technical aspects that need addressing surround issues of consistency, confidence and repeatability. These areas should be tackled by the JNCC Habitat Mapping and Classification Working Group and the HBDSEG Seabed Mapping Working Group.

(ii) There is a need for benthic ecologists (through the HBDSEG Benthic Habitats Subgroup and the JNCC Marine Indicators Group) to finalise the list of habitats for which extent and/or distribution indicators should be considered for development, building upon the recommendations from this report. When reviewing the list of indicators, benthic habitats could also be distinguished into those habitats that are defined/determined *primarily* by physical parameters (although including biological assemblages) (e.g. subtidal shallow sand) and those defined *primarily* by their biological assemblage (e.g. seagrass beds). This distinction is important as some anthropogenic pressures may influence the biological component of the ecosystem despite not having a quantifiable effect on the physical habitat distribution/extent.

(iii) The scale and variety of UK benthic habitats makes any attempt to undertake comprehensive direct mapping exercises prohibitively expensive (especially where there is a need for repeat surveys for assessment). There is a clear need therefore to develop a risk-based approach that uses indirect indicators (e.g. modelling), such as habitats at risk from pressures caused by current human activities, to develop priorities for information gathering.

The next steps that came out of the workshop were:

(i) A combined approach should be developed by the JNCC Marine Indicators Group together with the HBDSEG Benthic Habitats Subgroup, which will compile and ultimately synthesise all the criteria used by the three different groups from the workshop. The agreed combined approach will be used to undertake a final review of the habitats considered during the workshop, and to evaluate any remaining habitats in order to produce a list of habitats for indicator development for which extent and/or distribution indicators could be appropriate.

(ii) The points of advice raised at this workshop, alongside the combined approach aforementioned, and the final list of habitats for extent and/or distribution indicator development will be used to develop a prioritised list of actions to inform the next round of R&D proposals for benthic habitat indicator development in 2014. This will be done through technical discussions within JNCC and the relevant HBDSEG Subgroups. The preparation of recommendations by these groups should take into account existing work programmes, and consider the limited resources available to undertake any further R&D work.

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1. Introduction

The Marine Strategy Framework Directive (MSFD) (2008/56/EC) was formally adopted by the European Union in July 2008. It outlines a transparent, legislative framework for an ecosystem-based approach to the management of human activities which supports the sustainable use of marine goods and services. The overarching goal of the Directive is to achieve 'Good Environmental Status' (GES) by 2020 across Europe's marine environment (for more background information on the MSFD, see Annex C).

The Healthy and Biologically Diverse Seas Evidence Group (HBDSEG[1]) has been tasked with providing the technical advice for the implementation of the Directive in the UK with respect to Descriptors (D) linked to biodiversity (D1, 4 & 6). A number of biodiversity subgroups are taking this work forward, and the HBDSEG Benthic Habitats Subgroup is responsible for developing Research and Development (R&D) proposals for benthic habitat indicators that will contribute to the assessment of GES.

The MSFD initial assessment, based on the evidence collated for Charting Progress 2 (CP2), identified major evidence gaps on benthic ecosystems, particularly related to our overall knowledge on the distribution and extent of benthic habitats. The CP2 report stated that only 10-15% of the UK seabed has been mapped; the rest of what we know is based on modelling and interpolation of data. This evidence gap is a key issue that needs to be addressed in order to develop indicators under the Commission Decision (2010/477/EU) criteria 1.4 (habitat distribution) and 1.5 (habitat extent) for predominant and special habitats (Table 1:). Any qualitative or quantitative targets associated with indicators for these assessment criteria will need to relate to changes in the area and distribution of habitats. However, these changes can only be measured if we have adequate knowledge on the current extent and distribution of benthic habitats. It is also important to note that in some cases, data on extent and distribution will also be used for indicators under criterion 1.6 (habitat condition) and Descriptor 6 (seabed integrity) as part of evidence required to assess habitat damage.

One of the R&D proposals put forward by the HBDSEG Benthic Habitats Subgroup is titled*: 'Mapping the extent and distribution of habitats using acoustic and remote techniques, relevant to indicators for area/extent/habitat loss'* and was submitted to the Funders Group and HBDSEG to address the issues associated with the development of a MSFD extent/distribution indicator.

After further discussions between JNCC, Defra and HBDSEG, it was decided that a workshop was the most appropriate approach to define the way forward for the development of the '*Mapping the extent and distribution of habitats using acoustic and remote techniques, relevant to indicators for area/extent/habitat loss'* R&D proposal. The workshop took place in London and it brought together 27 technical experts from the UK (the full list of participants is available in Annex A) representing a range of scientific disciplines including specialists in mapping.

This report summarises the issues and advice that emerged from the workshop; these will be submitted to the HBDSEG and the Funders Group in order to inform the R&D programme supporting biodiversity indicator development.

[1] The Healthy and Biologically Diverse Seas Evidence Group (HBDSEG) of the UK Marine Monitoring and Assessment Strategy (UKMMAS) is responsible for coordinating and implementing monitoring and observation programmes, covering marine ecosystem health and biodiversity processes.

Table 1: Descriptors, criteria and indicators from the Commission Decision 2010/477/EU for which advice on targets and indicators was provided for benthic habitats (the criteria and indicators which could be relevant for this workshop are highlighted in bold typeface)

Descriptor	Criterion	Indicator
1 (Biological diversity)	**1.4 Habitat distribution**	**1.4.1 Distributional range**
		1.4.2 Distributional pattern
	1.5 Habitat extent	**1.5.1 Habitat area**
		1.5.2 Habitat volume, where relevant
	1.6 Habitat condition	1.6.1 Condition of the typical species and communities
		1.6.2 Relative abundance and/or biomass, as appropriate
		1.6.3 Physical, hydrological and chemical conditions
6 (Sea floor integrity)	6.1 Physical damage, having regard to substrate characteristics	6.1.1 Type, abundance, biomass and areal extent of relevant biogenic substrate
		6.1.2 Extent of the seabed significantly affected by human activities for the different substrate types
		6.2.1 Presence of particularly sensitive and/or tolerant species
	6.2 Condition of benthic community	6.2.2 Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species
		6.2.3 Proportion of biomass or number of individuals in the macrobenthos above some specified length/size
		6.2.4 Parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community

2. Aims of the Workshop

The main aim of the workshop was to allow marine benthic habitat experts to identify, define and assess the feasibility of potential indicators of benthic habitat distribution and extent, and identify the R&D work which might be required to fully develop these indicators. In order to generate a set of recommendations, the workshop participants were asked to focus on the following issues:

(i) *What is the status with the current extent and distribution indicator proposals, what current spatial data products are being used and what are their limitations?*

(ii) *Can and how can extent and distribution be defined for particular habitats/biotopes to allow a meaningful indicator to be developed? Specifically:*

- Which habitats are suitable for an indicator of extent/distribution?
- What current mapping data are available to support these indicators?
- Are indicators of extent/distribution feasible for the suitable habitats?

(iii) *How can we measure change in habitat extent and/or distribution directly or indirectly? Specifically:*

- Can/how can we measure change in habitat extent/distribution?
- What level of resolution/habitat classification is required for the analysis of habitat data?
- What potential R&D work is required for each relevant habitat to fully develop these indicators?

(iv) *How should baselines be used for potential habitat extent and/or distribution indicators*?

3. Approach and Organisation of the Workshop

The workshop was funded by Defra, chaired by Charlotte Johnston (Marine Biodiversity Monitoring Programme Leader, JNCC) and organised by Cristina Vina-Herbon (MSFD Senior Benthic Habitats Advisor, JNCC), and Rebecca Lowe (MSFD Habitats Advisor, JNCC), with support from Matt Frost (Benthic Habitats Group Joint Chair and Sediment Lead, MBA), Bill Sanderson (Benthic Habitats Group Joint Chair and Rock and Reefs Lead, Heriot-Watt University), Jo Higgs (Defra) and Kylie Bamford (Defra).

The two day workshop programme (see Annex B) comprised context setting, interactive breakout sessions and plenary sessions. The workshop benefited from nominated chairs of each session together with rapporteurs.

The following background documentation was made available to participants in advance of the workshop:

- MSFD background information (Annex C);
- Current spatial data products (Annex D);
- Draft rationalised list of habitats document[2] (Annex E);
- JNCC Report 464: Reviewing and Recommending Methods for Determining Reference Conditions for Marine Benthic Habitats in the North-East Atlantic Region.[3]

The scope of the workshop was set out in Session 1. Subsequently, attendees were subdivided into three subgroups, for Sessions 2 to 4. In the subgroups the draft rationalised list of habitats was used as a template to answer all of the questions asked about each habitat. The list was split amongst the subgroups, in order to review as many of the habitats as possible. Using their set list of habitats, each subgroup was requested to:

- Identify and define potential habitat extent and/or distribution indicators in Session 2;
- Discuss how we can measure change in habitat extent/distribution indicators in Session 3;
- Discuss how baselines should be used for potential habitat extent/distribution indicators in Session 4.

Each of the subgroup Sessions (2 to 4) was followed by a plenary session to ensure emerging difficulties were dealt with quickly, and to secure a standard understanding of the way forward.

The workshop did not specifically cover any data issues, however, throughout the subgroup Sessions, key data issues were noted under the following topics: (i) new mapping needs, (ii) issues with existing maps and data products and (iii) general issues.

[2] To note, the report was still in draft form and contained 73 habitats on the list at the time of the workshop. Since then, the report has been published (Robson, L. 2014. Monitoring, assessment and reporting of UK benthic habitats: A rationalised list, JNCC Report 499, JNCC, Peterborough. Available from: http://jncc.defra.gov.uk/page-6671) and now contains 76 habitats. Additional habitats on the published list but not included in the workshop include: Carbonate Reefs, Intertidal mudflats, Offshore deep sea muds and Zostera beds. One habitat was excluded from the published list but was included in the workshop: Subtidal mixed muddy sediments.

[3] Report is available from: http://jncc.defra.gov.uk/pdf/464_web.pdf

4. Workshop Outcomes

This section outlines the issues and advice that emerged from the workshop. All of the results and discussion points per habitat for Sessions 2-4 are available in Section 5, and the more general discussion points are available in Annex F.

4.1. Session 1: What is the status of the current extent and distribution indicator proposals, what current spatial data products are being used and what are their limitations?

(i) Presentations were provided in this Session on the following subjects:

- An introduction to the MSFD and the targets and indicators which were submitted to the European Commission in 2012, including a summary of the current status of the UK benthic habitat indicator proposals noting the range of habitats for which information is required and the challenge in setting targets (see Annex C for more information).
- An overview of the current spatial data products noting the limitations of predictive seabed maps. It was noted that some of the apparent change in habitat extent could be caused by changes in methodologies and data availability instead of real changes in the extent of habitats (see Annex D for more information).

(ii) A number of issues were raised by the participants during Session 1. Most of these issues were technical in nature, particularly there was a general consensus that there is a lack of consistency as to how technical issues such as scale, resolution and interpretation of mapping outputs are dealt with, and used by, different organisations. Furthermore, it was felt that there is a need to improve the coordination and understanding of 'who does what' in terms of data collection and mapping. Other issues that were raised in this session related to our lack of understanding on the ecological distribution and environmental niches in which certain habitats occur (e.g. deep-sea sponge communities), and also the lack of clarity and confusion around certain habitat definitions.

(iii) The following points of advice were raised by participants during Session 1:

1. For the development of MSFD indicators, there is a need to develop clear rules for the mapping of benthic habitats to ensure a consistent approach to the measurement of extent and distribution (e.g. the minimum mapping unit, and the component that is to be mapped, such as lagoon basin or water surface area).

2. Information from organisations involved in mapping activities (techniques, scale and resolution) needs to be compiled and assessed to inform indicator development, in particular to provide advice on the technical approaches and range of metrics that could be used for indicator development.

3. Accessibility to mapping/survey data and industry data needs to be improved, and agreements need to be put in place, in order to help reduce the costs of data collection and monitoring of extent/distribution indicators.

4. Pressure mapping needs to be at an appropriate temporal and spatial scale (and frequency) in order to assess the potential impacts on particular habitats under consideration.

5. For the delivery of monitoring programmes associated with extent and distribution indicators, there needs to be an agreement with all organisations involved, to maximise the use of vessels capacity and aid the coordination of the monitoring programmes.

6. For the delivery of monitoring programmes, there is a need for greater consideration of Autonomous Underwater Vehicles (AUV), amongst other techniques, to undertake monitoring of habitat extent and impact from pressures in particular for offshore/deep-sea habitats.

7. R&D work is required to ascertain how mapping could be used to measure distributional pattern.

4.2. Session 2: Can and how can extent and distribution be defined for particular habitats/biotopes to allow a meaningful indicator to be developed?

(i) Two case studies were presented in this Session:

- "*EC Habitats Directive – Assessing the area parameter of Favourable Conservation Status*". This case study focussed on the difficulties of assessing the area parameter in the current Article 17 2013 reporting round.
- "*Mapping the extent of marine features in Wales*". This case study focussed on the strengths and weaknesses of the current Welsh feature maps and also looked into mapping challenges currently being faced in Wales.

(ii) Following the case studies, the participants split into three groups to further discuss whether defining extent and/or distribution for particular habitats would be meaningful. Many of the issues and points raised during this session were focussed on the biological/ecological aspects to assess the suitability of developing extent and/or distribution indicators. It was noted that some anthropogenic pressures may influence the biological component of the ecosystem, despite not having a quantifiable impact on the physical habitat extent, and so in some cases condition indicators may be more appropriate. There was also a general consensus among the participants that extent and distribution indicators should be considered separately because the ecological aspects to be considered for extent and distribution are slightly different. For example, in some cases, extent would be more important as an indicator for some slow growing habitats (e.g. maerl beds boundaries) and in other cases, distribution indicators would be more important (e.g. ephemeral habitats). A number of mapping issues were also raised, for example it was acknowledged that some predominant (broad) habitats (such as intertidal sand, intertidal mixed sediments, intertidal mud) cannot be easily separated with aerial photography or remote sensing. Furthermore, there was overall agreement that there is a need to understand the resolution of maps and the degree of change that can be measured with reasonable confidence.

(iii) The following points of advice were raised by participants during Session 2:

8. When selecting techniques to be used for the development of an extent and/or distribution indicator, greater focus should be given to the type of communities defining the habitats, in particular if they are mainly based on epifaunal or infaunal species. Habitats defined by infaunal communities, although impacted by pressures, are in many cases unfeasible for mapping using only remote techniques.

9. Extent and/or distribution indicators are appropriate ***only*** when pressures[4] are known or are expected to cause a change in the extent and distribution of a given habitat.

10. A distribution indicator rather than extent indicator should be considered for ephemeral and naturally variable habitats, and in particular consideration should be given to the connectivity aspects between areas where the habitat occur, and the potential risk of fragmentation to their distributional range.

11. In most cases, extent indicators are ***not*** appropriate for habitats when seasonal/natural variability is much greater than any change brought about by a pressure.

12. Extent and/or distribution indicators are ***not*** appropriate for any habitat that ***cannot*** be feasibly mapped with the array of techniques available to us (i.e. acoustic, remote sensing, ground-truthing).

13. There are not enough resources to develop indicators for all habitats and so a prioritisation exercise is required to determine which habitats should be given higher priority.

4.3. Session 3: How can we measure change in habitat extent and/or distribution directly or indirectly?

(i) A case study was presented on the "*Development of spatial assessment of rocky reefs/biogenic structures*". This presentation focused on ways indicators could be measured (interpolation between sample points, modelling habitats or direct monitoring).

(ii) Following the case study presentation, the participants split into three groups to further discuss how we can measure change in habitat extent and distribution indicators. Most of the issues and points raised by participants in this session were technical in nature. The issue of standardisation was frequently mentioned as a priority to be addressed particularly in relation to methodology (sampling and data interpretation), in order to allow us to detect real change in extent/distribution instead of changes due to methodological variations. The participant's preferred option to measure change in habitat extent would be to use direct measurement (i.e. combination of remote sensing and groundtruthing) to define baseline extent, and use further direct measurement to assess any changes in extent, albeit this can be considered costly. It was also noted that for some habitats (e.g. sponge on rock, or under-boulder communities), it is hard to map not only the actual extent/distribution, but also any changes caused by human pressures, hence condition assessments could be more appropriate. However, spatial extent information would still be needed to assess the condition of the habitat within its overall extent and distribution (i.e. *how much* of your habitat is at GES). Finally, it was acknowledged that for some habitats (e.g. fragile sponge and anthozoan communities), loss of habitat may be hard to detect via acoustic survey, which could be due to the limitation of the techniques or nature of environment under investigation, and as such repeat acoustic monitoring may not be appropriate.

[4] The term 'pressures' is considered here as those pressures that are *currently* occurring and those that can be immediately anticipated rather than any future hypothetical pressure levels.

(iii) The following points of advice were raised by participants during Session 3:

14. Building upon existing methodologies, R&D is required to scope out the development of approaches to consider the best way to combine direct (e.g. remote sensing) and indirect (e.g. modelling) methodologies for detecting change in extent and/or distribution, with a particular focus on the costing of monitoring.

15. R&D is required to look into the development of systems that will allow us to track developments (e.g. licensing schemes) in real time as a proxy for activities' impacts, to (a) help us estimate change in habitat extent/distribution and (b) use a risk-based approach to focus on those habitats or areas that are most vulnerable to the developments.

16. A rule-based, spatially 'nested approach' should be investigated where different, yet consistently defined scales are applied to mapping and assessment using standardised methodologies.

17. An evaluation exercise needs to be undertaken which aims to clarify which habitats have distinct acoustic signatures that can be detected by remotely survey techniques, and therefore to ascertain if changes due to human pressures on habitat extent and/or distribution could be reliably detected using acoustic techniques.

18. The Aerial Monitoring Working Group under HBDSEG should continue to investigate and report on more recent mapping techniques including satellite and LiDAR, and how these methodologies could be used to build up or provide the basis for the development of extent and/or distribution indicators.

4.4. Session 4: How should baselines be used for potential habitat extent and/or distribution indicators?

(i) A presentation on reference conditions was provided summarising the methods used for determining reference conditions for habitat extent and distribution and the challenges associated with these methods.

(ii) Following the presentation, the participants split into three groups to further discuss what baselines we should be using for each habitat and how we can detect real change in extent over time. The issue of standardisation came up again in the baselines discussion in that to detect real change (as opposed to apparent change as a result of methodological artefacts), data collection methodologies will need to be standardised. Also, it was noted that the frequency of monitoring and assessment (and adjustment of baseline/reference points) will vary between features depending on the stability of the feature and its vulnerability to pressures. There was a discussion on historical 'reference conditions', which are generally considered useful for baseline setting but the definition of 'historical' needs to be considered. Furthermore, there may need to be different baselines for extent and distribution depending on the feature type and whether historical data is available.

(iii) The following points of advice were raised by participants during Session 4:

19. In principle, the baseline for marine habitats of the Habitats Directive should be aligned with the Marine Strategy Framework Directive.

20. A calibration exercise is needed for the development of historical baselines to ascertain whether the methodologies used in the past are comparable with those currently being used in order to ensure that any indication of change is a result of habitat change and not caused by methodological differences.

21. In order to detect real change (as opposed to apparent change as a result of methodological artefacts), data collection methodologies for baselines and assessment will need to be standardised.

22. Frequency of monitoring could be based on a risk-based approach to target features most at risk.

5. Results from the Rationalised Habitat List Discussions

The draft rationalised list of habitats was used as the starting point for the evaluation of developing extent and/or distribution indicators per habitat.

At the workshop, participants were split into three groups to discuss a selection of habitats from the draft rationalised list as described in Section 3.4; however due to time limitations, it was not possible for the groups to finalise the whole list (the total number of habitats on the draft rationalised list was 73 at the time of the workshop – see footnote 2 for more information). Furthermore, the three different groups worked separately from each other, and their considerations during the evaluation differed slightly. At the workshop it was discussed and agreed that this work should continue, and that a combined approach (based on the group's individual approaches) should be produced for the selection of habitats for extent and/or distribution indicator development. The initial evaluation done by the participants at the workshop is therefore considered a first attempt, which will be further evaluated based on this combined approach to produce a final list of habitats for extent and/or distribution indicator development.

The overall results from the initial evaluation of the draft rationalised list of habitats can be found in Table 2.

Table 2: Overview of the results from Session 2 as to which habitats (on the rationalised list) an extent/distribution indicator was considered appropriate.

Indicator type	**Predominant (n=26)**	**Special Habitats & other habitats (n=47)**
Number of habitats for which an extent and/or distribution indicator was considered appropriate	4	27
Number of habitats for which an extent and/or distribution indicator was NOT considered appropriate	16	15
Number of habitats that were not evaluated	6	5

All of the results and discussion points for Sessions 2-4 per habitat can be found in Table 3, which displays the entire rationalised list of habitats including those that were not covered in the time available. Some key statistics from this table for each session are:

- Session 2: Overall, the subgroups evaluated 62 out of the 73 habitats to assess whether they believed an extent and/or distribution indicator would be appropriate for a particular habitat or not. Of those 62 habitats that were evaluated, an extent and/or distribution indicator was considered appropriate for 31 habitats.
- Session 3: For the 31 habitats for which an extent and/or distribution indicator was considered appropriate, the subgroups concluded that we can measure change in habitat extent and/or distribution directly for 16 habitats and indirectly for 9 habitats.
- Session 4: The subgroups had time to review 16 of the 73 habitats to discuss what baselines we should be using for particular habitats.

Table 3: Rationalised List of Habitats Template containing the results and discussions from each of the subgroups for Sessions 2-4 (the questions match those asked under each Session within the Workshop Programme (Annex B))

		SESSION 2							SESSION 3						SESSION 4		
Group Number[5]	Habitat with an assessment and reporting requirement	Is the EXTENT of this habitat influenced by human pressures that we can measure (y/n)?	Comments	Is the DISTRIBUTION of this habitat influenced by human pressures that we can measure (y/n)?	Comments	What data sources are available in broad categories of data type for this habitat?	Is an extent/distribution indicator appropriate for this habitat?	Comments	Can we measure change in habitat extent/ distribution directly (y/n)?	Comments (Level of resolution/scale)	If not directly, can we opt for an indirect approach to measuring habitat extent/distribution (y/n)?	Comments (indirect approaches)	What methodologies/mapping activities are required to measure change in habitat extent/distribution?	Is there any potential R&D work that is required to measure change in habitat extent/distribution?	What baselines should we be using?	What baselines can be derived from our maps?	How do you detect real change in extent over time compared to change due to improved methods of measurement?
1	**Annual vegetation of drift lines (*Cakiletea maritimae* class)**	YES	Can be influenced by human pressure but can only be measured on a small scale.	YES	Can be influenced by human pressure but can only be measured on a small scale.		NO	High natural variability - too great to have meaningful results.									
2	**Atlantic salt meadows (*Glauco-puccinellietalia maritimae*)**	YES	Pressures: land reclamation, coastal development, over-grazing, any impacts on the hydrographic regime (e.g. coastal defence).	YES	Pressures: land reclamation, coastal development, over-grazing, any impacts on the hydrographic regime (e.g. coastal defence).	MB0102 Task 2C[6], Environment Agency airborne remotely sensed data, new intertidal maps.	YES	Because it is at risk of some human pressures.	YES		N/A	N/A	Aerial survey and ground-truthing (Water Framework Directive monitoring programme).		Reference conditions, all methods applicable.	Current existing reference conditions can be derived from maps but modelling and hind-casting would be required to produce maps of historical reference conditions. We can then assess whether current extent is within sustainable use to allow targets & conservation objectives to be set.	Measure change in known anthropogenic change in extent rather than overall change in extent? Although this risks missing changes that are not actively being sought through pressures. Take a risk-based approach to monitoring areas where there is a risk of hydrographic changes and use known licensed areas to target sampling.
3	**Carbonate mounds**	YES	Pressures: demersal trawling but not considered significant.	YES	Could argue that extent and distribution for carbonate mounds is one and the same	Survey data (multibeam plus ground validation), fisheries anecdotal evidence.	NO	Unlikely that the extent will be impacted in a significant way by pressures.									
1	**Coastal (saline) lagoons**	YES	Pressures: coastal development	YES	Can quantify developments.		YES	Should be relatively simple.	YES	Aerial photos, LIDAR[7]. Would need a set of rules to define whether a lagoon is still a lagoon - although might be site specific.			Aerial photos, LiDAR, foot survey (direct observation). Might be number of lagoons that we want to look at, not area.	Tighten up definition.	Using older baselines (pre 1994) has a risk of including lagoons that have been lost due to coastal erosion. Could use Habitats Directive 1994 baseline if there is one.	Unsure but think the extent should have been mapped in 1994.	Need calibration for any changes in method. But if measure is a simple count then it would be quite straightforward.

[5] This column titled "Group Number" displays which subgroup reviewed the different habitats
[6] MB0102 was a Defra funded contract with the key aim of developing the necessary data layers for the identification of a network of Marine Conservation Zones (MCZs). Task 2c focussed on the mapping of protected habitats.
[7] LiDAR is a remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. It is popularly known as a technology to produce high resolution maps.

		SESSION 2							SESSION 3						SESSION 4		
Group Number[5]	Habitat with an assessment and reporting requirement	Is the EXTENT of this habitat influenced by human pressures that we can measure (y/n)?	Comments	Is the DISTRIBUTION of this habitat influenced by human pressures that we can measure (y/n)?	Comments	What data sources are available in broad categories of data type for this habitat?	Is an extent/distribution indicator appropriate for this habitat?	Comments	Can we measure change in habitat extent/ distribution directly (y/n)?	Comments (Level of resolution/scale)	If not directly, can we opt for an indirect approach to measuring habitat extent/distribution (y/n)?	Comments (indirect approaches)	What methodologies/mapping activities are required to measure change in habitat extent/distribution?	Is there any potential R&D work that is required to measure change in habitat extent/distribution?	What baselines should we be using?	What baselines can be derived from our maps?	How do you detect real change in extent over time compared to change due to improved methods of measurement?
2	**Coastal saltmarsh**	YES	Pressures: land reclamation, coastal development over-grazing, any impacts on the hydrograph-ic regime (e.g. coastal defence).	YES	Pressures: land reclamation, coastal development, over-grazing, any impacts on the hydrographic regime (e.g. coastal defence).	MB0102 Task 2C, Environment Agency airborne remotely sensed data, new intertidal maps.	YES	Because it is at risk of some human pressures.	YES		N/A	N/A	Aerial survey and ground-truthing (Water Framework Directive monitoring programme).		Reference conditions, all methods applicable.	Current existing reference conditions can be derived from maps but modelling and hind-casting would be required to produce maps of historical reference conditions. We can then assess whether current extent is within sustainable use to allow targets & conservation objectives to be set.	Measure change in known anthropogenic change in extent rather than overall change in extent? Although this risks missing changes that are not actively being sought through pressures. Take a risk-based approach to monitoring areas where there is a risk of hydrographic changes and use known licensed areas to target sampling.
3	**Cold water coral reefs (*Lophelia pertusa*)**	YES		YES		Survey data, fisheries data.	YES	Likely to be impacted and one of the prime habitats where we should be measuring extent because the habitat is sensitive.	YES	High resolution acoustic survey is needed. Use a risk-based approach.			Acoustic survey with ground-truthing (requires sufficient resolution to be used for acoustic signature to detect reef areas). One-off ground-truthing exercise could confirm the presence of reef, followed by repeated acoustic survey to monitor extent. Potential for using Autonomous Underwater Vehicles for monitoring work - this would reduce pressure on acoustic survey vessels and reduce costs.	Impacts and pressures already quite well under-stood; work is needed to better under-stand patchiness.	Historical data with expert judgement (distribution) combined with current data from acoustic surveys (for current known distribution and extent). Habitat suitability modelling could be used to predict maximum potential distribution. Baseline will be based on all currently available information. Baseline/reference point may change depending on discovery of new reef areas. Distribution baseline may be based on historical data; extent baseline will be based on current data.	Maps based on historical, current and modelled data with expert judgement applied. Maps may be different for distribution and extent.	Understand accuracies of mapping methods; knowledge of pressures may allow changes due to activities rather than mapping methods to be distinguished. Data availability may increase over time - this needs to be accounted for but may not reflect natural change. Repeat surveys at the same site will allow real changes to be distinguished from "artificial" changes due to mapping techniques and technology. (Need consistency in mapping methods and interpretation).
1	**Coral gardens**	YES	Is the impact on extent or quality? Extent because organisms can be removed.	YES			NO	For soft organisms, it is very hard to map using acoustic techniques. Could try photographic techniques but likely to be very expensive. Also need definition to be clarified before this can be properly progressed.									

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2	**Deep-sea sponge aggregate-ons**	YES	Pressures: Mainly exploratory - trawling (affected by but not targeted).	YES	Based on the maximum depth that trawling occurs in this might increase in future; however apart from the likely increase in trawling depths, currently damage only occurs in specific areas, not really affecting the range or pattern.	OSPAR habitat mapping data[8], predictive modelled maps (Plymouth University), by-catch from trawling (through a reporting initiative) - point records of presence.	YES	Because it is at risk of some human pressures.	NO	It is not known everywhere it exists and is unlikely to be in the near future.	YES	Modelling is developing/ improving for this habitat (University of Plymouth).	Overlay Vessel Monitoring System pressure data (at a good resolution) with models to predict changes in extent.	Validation of models by new data using this to improve future models.	Reference conditions via modelling & groundtruthing with current extent data. Current state is close to what it used to be but it is uncertain what the current state actually is in terms of extent/distribution. Less historical data available than for corals etc.	Video and stills data is available but no effective remote sensing techniques. Could target with Autonomous Underwater Vehicles if these ever become cheap enough. Current maps are not of high confidence for extent/distribution.	Risk-based approach? Model the habitat and target these areas for validation with ground truthing. Used fixed sample points along with pressures information to monitor whether known sponge areas have changed due to human pressures. Need research to validate the impact of pressures on sponge aggregations in order to use this approach reliably.
3	**Estuaries**	YES	Pressures: dredging, barrages, coastal development.	YES	It is unlikely that a whole estuary would be lost or gained.	Survey data, historical information etc.	YES	Potentially just for extent and not so much for distribution.	YES	UK-wide scale - may need to prioritise the frequency with which individual estuaries are monitored.			Aerial photography and/or LiDAR; knowledge of licensed (and unlicensed) activities. Both direct and indirect measures of pressures need to be used. Coastal modification/flood defence work. Port authorities already collect data within estuaries (sometimes hard to acquire data). Small-scale losses are hard to keep track of and are not necessarily monitored. TraC-MImAS[9] could be used to track changes in estuary integrity, Water Framework Directive hydromorphology tool.	Data on estuaries is collected by many bodies such as port authorities etc. This is not always readily available; need to progress work on improving data access to avoid duplication of effort and reduce costs of monitoring. Need to under-stand which estuaries are under highest current and future pressures; what are the pressures associated with individual estuaries?	Baseline and reference points likely to be different. (The Environment Agency has dataset of historical extent of estuaries - as used in Charting Progress 2). Reference point could be based on historical data; baseline would be set at a more recent point in time. Need to be able to distinguish between natural variability in estuary extent from real losses or gains of feature. Reference point could be set at "pre-anthropogenic" conditions, but this state cannot realistically be achieved, so baseline and target would be set in relation to current conditions (e.g. prevent no further loss in extent). Target could be a trend towards achieving a certain extent of estuarine habitats; likely to be different for each estuary. Distribution and extent would be based on historical data. Mapping pressures will be more important than mapping extent.		Natural variability likely to be significant; focus on areas of known pressures (habitat loss) and/or creation from.

[8] The OSPAR habitat mapping data includes all of those habitats that are on the OSPAR list of threatened and/or declining habitats in the North-east Atlantic and is managed by Helen Ellwood at the Joint Nature Conservation Committee.
[9] TraC-MImAS (Transitional and Coastal Waters Morphological Impact Assessment System) is a risk-based regulatory decision-support tool that was developed to help regulators determine whether proposals to alter hydromorphological features could risk the ecological objectives of the WFD.

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1	**Estuarine rocky habitats**	YES	Pressures: Coastal development.	YES	Pressures: Coastal development but less likely.		YES	Need to link to pressure monitoring. Some issues with habitat definition.	YES	Might be a bit difficult to delineate stony and sediment habitat from aerial photos. Might need to survey questionable areas on foot.	YES	Could map the rocky habitats once then look on aerial photos plus on licensed activities records for losses and/or gains. Some discussion as to whether this count as direct or indirect method (generally think indirect).	Aerial photos, groundtruthing and pressure maps.	Calibration needs to be developed for interpretation of aerial photos. Also need a very consistent set of rules/protocols.	Most pragmatic approach at the moment is probably to set current baseline. Historical baseline might be appropriate as habitat has been impacted. Might be able to find old maps that can provide info. Should also look at what extent is today and see if there is much difference from historical estimates. If there is not much difference then use current extent. This might be quite time consuming although the technology does exist to examine old maps. But note that we also need to decide how important it is to set an accurate historical baseline when the target is likely to be different (because areas that have been lost probably cannot be recovered)? Issue of prioritisation of resources.	Aerial photos, old maps may be possible data sources.	Calibration of methods to examine aerial photos etc.
72	**File/flame shell beds (*Limaria hians*)**	YES	Pressures: dragging lobster pots, trawling.	YES	Rare, localised feature with a relatively small range and so relatively small changes in extent may result in a range and pattern change.	MB0102 Task 2C, mainly point data from diving and maps derived from these points, possibly detect by acoustic data.	YES	Because it is at risk of some human pressures.	YES	Cannot detect with remote sensing; need repeat diving surveys. We can detect local changes but can't be sure where they are everywhere.	YES		Dive sampling at sites predicted by models.	Try and model the occurrence of this habitat to stratify monitoring - not yet been done to our knowledge.	Reference conditions via predictive modelling and groundtruthing with current data. Impacts on this habitat type are likely to have been significant in the past, and historic data is sparse.	Current maps are not suitable for use as a baseline. They could be used to stratify a sampling strategy and validate predictive modelling.	Potential remote method of detecting the habitat type - cone penetrometer? This will be very dependent on survey/mapping effort as extent will increase with effort. Perhaps use known areas and number of hits or timed diver search to measure change in extent as opposed to trying to measure overall extent. Perhaps would need to measure change in trend of habitat extent, as opposed to an absolute value of extent required.

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3	**Fragile sponge and anthozoan communit-ies on subtidal rocky habitats including northern sea fan and sponge communit-ies**	YES	Pressures: fishing, sediment loading. Substrate will be very difficult to change - it is more the biological elements which may change as a result of pressures.	YES		Survey data, fisheries data.	YES	Likely to be impacted. Not as slow-growing, long-lived as cold-water coral reefs.	NO	Measuring change is possible BUT an unrealistic survey programme would be needed to effectively map change in extent. Survey effort would require complete ground-truthing surveys over large areas. Could apply a risk-based approach to monitoring and focus on locations where habitat occurs in small patches that have local importance. This approach may be important for measuring distribution of habitat. Mapping distribution - more important than extent (loss of small areas may have a significant impact on distribution patterns).							
1	**Inshore deep mud with burrowing heart urchins (*Brissops-is lyriferai*)**	YES	Pressures: potential fishing impacts which could remove the urchins.	YES	Pressures: Potential fishing impacts which could remove the urchins.		NO	Difficulty of mapping the organisms effectively. But could possibly map the pressure and make some assumptions. But these assumptions might not be valid, especially without a survey programme as extent could increase elsewhere. Also sampling would be destructive in terms of the urchins. Impact on condition of the habitat will be more important.									

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2	**Intertidal chalk and associated communit-ies**	YES	Pressures: coastal development.	YES	Rare, localised feature with a relatively small range, so relatively small changes in extent may result in a range and pattern change.	British Geological Survey, local authority data collected for developme nt/ planning, Environme nt Agency airborne remote sensing.	YES	Because it is at risk of some human pressures.	YES		N/A		Phase I intertidal survey	No	Reference conditions - current existing extent is likely to be reference condition. Local declines in the UK are already documented through historic construction so a full baseline can be constructed from this data.		Overlay the footprints of future impacts causing habitat loss.
3	**Intertidal *Mytilus edulis* beds on mixed and sandy sediments**	YES	Pressures: fishing, dredging.	YES		Survey data.	YES	Ephemeral – more important for distribution. It is more important that it is present within an area rather than its full extent within that area). The question of scale is also important.									
1	**Mudflats and sandflats not covered by seawater at low tide**	YES	Pressures: coastal development.	YES	Pressures: Coastal development.		YES	Aerial photography and also records of developments.	YES	Aerial photos and need to groundtruth on foot. Also need to get an idea of natural variation. So do once every reporting cycle.	YES	Could look at aerial photos for developments plus look at licences for developments.		Calibration needs to be developed for interpretation of aerial photos. Plus need very consistent set of rules/protocols.	This habitat has been lost due to pressures such as coastal defence and land reclamation. There has been a greater loss for this habitat than for estuarine rock. So appropriate to set historical baseline. Would have to go back to a variety of historical sources. But quite resource heavy to do this work. Note that target might end up being roughly what we have today. It might also be that extent is measured from the point at which the first good aerial photos were created in order to inform targets and trends.		
2	**Intertidal underbou-lder communit-ies**	YES	Pressures: bait collection, coastal development.	YES	Because it is patchy, proximity to human populations might affect distribution.	Some Statutory Nature Conservati-on Body point data available and some polygon data in Wales.	NO	More suited for condition assessment.									
3	**Kelp and seaweed communit-ies on sublittoral sediment**	YES		YES		Survey data and modelled data.	YES	Ephemeral.									

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1	**Large Shallow Inlets and Bays**	YES	Pressures: loss of parts of natural habitat from within larger feature.				NO	More appropriate to measure at scale of broadscale or important habitats within the feature.									
2	**Maerl beds**	YES	Pressures: suction dredging, aggregates, fishing, anchors, scallop dredging, harbour maintenance.	YES	Because it is patchy, it could affect the distribution.	OSPAR habitat mapping data, harbour authorities, Statutory Nature Conservati-on Bodies, predictive models, Wildlife Trusts, Non-Governme-ntal Organisati-ons.	YES	Because it is at risk of some human pressures.	YES		N/A		Video survey, sometimes detectable with acoustic survey.	Analysis of how much video data is required to measure a significant change in extent.	Reference conditions constructed through predictive modelling (with verification) and historic data of extent/distribution.	Current maps are not suitable for a reference conditions baseline. Modelling will be required to produce a baseline map.	High risk that increased survey effort will create perceived increase in extent. Need to separate out the change due to increased data /modelling of extent and change due to human impacts. Stratify sampling to those known areas to pick up impacts in these areas. Needs to be an ongoing programme of model verification to create more robust areas where the habitat should occur.
3	**Maerl or coarse shell gravel with burrowing sea cucumber-rs (*Neopent-adactyla mixta*)**	YES		YES		Survey data.	YES	Far more spatially restricted and prone to aggregate extraction.									
1	**Mediterra-nean and thermo-Atlantic halophilo-us scrubs (*Sarcoco-rnetea fruticosi*)**							Not much is known about this habitat. Although assume similar answers to other intertidal habitats.									

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2	**Modiolus modiolus beds**	YES	Pressures: anchors, scallop dredging, trawling, maintenance dredging.	YES	Because it is patchy, this could have an impact on distribution.	OSPAR habitat mapping data, Statutory Nature Conservati-on Bodies, predictive models, Non Governme-ntal Organisati-ons.	YES	Because it is at risk of some human pressures.	YES	But not always in the same way. Questions about when it becomes a "bed" – Heriot- Watt University are looking into this at the moment.	N/A		Hydro-acoustic and ground-truthing, including video tows.	Try and model the occurrence of this habitat to stratify monitoring - PhD student at Heriot- Watt doing this.	Reference conditions constructed through predictive modelling (with verification - mixed success so far with modelling Modiolus) and historic data of extent/distribution.	Current maps are not suitable for a reference conditions baseline. Modelling will be required to produce a baseline map but this modelling may not be very reliable.	High risk that increased survey effort will create perceived increase in extent. Need to separate out the change due to increased data /modelling of extent and change due to human impacts. Stratify sampling to those known areas to pick up impacts in these areas. Needs to be an ongoing programme of model verification to create more robust areas where the habitat should occur.
3	**Mud habitats in deep water/ offshore deep seas muds**	NO	More predominant-less of a biological element. Habitat itself is defined by its physical parameters. Not that which can be measured.	NO	More predominant-less of a biological element. Habitat itself is defined by its physical parameters. Not that which can be measured.		NO	Unlikely that the extent/ distribution will be impacted in a significant way by pressures.									
1	***Musculus discors* beds**	YES	Presumably can be impacted by fishing.				NO	Very hard to map its extent. Not that much knowledge of its sensitivity to different pressures. Need more scientific information to progress this one.									
2	***Mytilus edulis* beds**	YES	Pressures: harvesting, anchors, scallop dredging, trawling, maintenance dredging, eutrophication and other pollution. Sometimes human activities can have a positive effect (e.g. if it includes mud substrate then mussel farms might increase local beds).	YES	Widely distributed and occurs in a range of environmental conditions so is quite resilient. Connectivity is also important. The effect is on the PATTERN but not the RANGE.	OSPAR habitat mapping data, Statutory Nature Conservati-on Bodies, Non Governme-ntal Organisati-ons, fisheries agencies.	YES	Some beds are persistent whereas others come and go. Difficult to distinguish those effects that are natural from anthropogenic causes. Need to consider this - maybe focus on the more persistent beds.	YES	More so with the more persistent beds. Associated with a vast range of environmental conditions - may be hard to model and therefore narrow down potential areas of occurrence.	N/A		Not too difficult if inter-tidal. Side-scan for subtidal with ground-truthing. Possibly airborne with ground-truthing intertidally.	Feasibility study needed - talking to fisheries experts.			

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3	**Offshore subtidal sands and gravels**	NO	More predominant-less of a biological element. Habitat itself is defined by its physical parameters. Not that which can be measured.	NO	More predominant-less of a biological element. Habitat itself is defined by its physical parameters. Not that which can be measured.		NO	Unlikely that the extent/ distribution will be impacted in a significant way by pressures.									
1	***Ostrea edulis* beds**	YES	Pressures: fishing, disease and others.	YES			YES	Should be ok to use acoustic techniques.	YES	Need to check habitat definition in terms of density of oysters. If dense then should be able to do acoustic survey, although need to be sure not measuring *Crassostrea*. Might also be possible to do diver surveys or video? Is there any certainty at the moment where all the oyster beds are?		Very hard to do at present.	Acoustics plus ground truthing.	Work is required to see if an acoustic signature for oyster beds can be defined. Plus best acoustic device to use for this. Need to define edges, plus need to be able to separate from *Crassostrea.*			
2	**Peat and clay exposures (with piddocks) (to include littoral and sublittoral)**	YES	Pressures: Subtidal: dredging, coastal morphological.	YES	Rare, localised feature with a relatively small range, so relatively small changes in extent may result in a change in pattern/range.	Sparse data, Statutory Nature Conservati-on Bodies, incidental presence data from industry.	NO	Limited pressures in intertidal and too small a scale in subtidal for mapping.									
3	***Sabellaria alveolata* reefs**	YES	Pressures: coastal development, water quality, barrages.	YES		Survey data.	YES	Ephemeral habitat – more important to measure distribution than extent (more spatially localised, easier to do).									
1	***Sabellaria spinulosa* reefs**	YES	Pressures: fishing, aggregate extraction and other impacts.	YES			YES	But in reality difficult to measure. Also has high natural variability in extent and distribution.		Has an acoustic signature but we can't do acoustic survey everywhere. Plus seems to move around over time naturally.				Need to know more about the natural variability of this habitat. No conclusion to this one. It might be worthwhile looking at whether doing directed surveys in certain selected sea areas might work? Plus further work on what impacts them. Need a closed area to use for scientific study.	Has high natural variability. Therefore historic information is not necessarily that useful as it will come and go over time. But there are some stable reefs (e.g. in the Bristol Channel), which have been there for years? Only pragmatic option might be to start baseline now. Although still need to work out how to measure it - possibly encounter rate type methodology. Habitat suitability modelling probably not practical as we don't currently seem to understand where it might or might not be.		

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2	***Salicornia* and other annuals colonising mud and sand**	YES	Pressures: land reclamation, coastal development, over-grazing, any impacts on hydrographic regime, (e.g. coastal defence).	YES		MB0102 Task 2C, Environme-nt Agency airborne remotely sensed data, new intertidal maps.	YES	Because it is at risk of some human pressures.							Possibly the same as coastal saltmarsh – there is uncertainty, so more focused expertise is needed.		
3	**Sandbank-s which are slightly covered by sea water all the time (≤20m water depth)**	NO	Pressures: aggregate extraction, dredging. To impact on the entire sandbank is unlikely rather it would reduce the area of the sandbank. Focusing on a topographic description of sandbanks.	NO			NO	Unlikely that the extent/distribution will be impacted in a significant way by pressures.									
1	**Seagrass beds/ *zostera* beds**	YES		YES			YES		YES	Quite time consuming, still working on best way to survey subtidal. Possible techniques - diver, LiDAR, photography (Environment Agency Water Framework Directive work).		Probably not appropriate.		Continue looking for best methods in subtidal, especially in more turbid conditions.	Historic but need expert judgement to consider impacts of disease - long discussion about whether to include loss from disease in baseline or not. It's a natural (probably) impact so we could exclude it. But seagrass habitat is beneficial and limited in extent so maybe we want to set the baseline pre disease? Habitat suitability modelling might work?		
2	**Sea loch egg wrack beds (*Ascophyl-lum nodosum)***																
3	**Seamount-s (with associated communit-ies)**	NO	There are some types of activities that could remove communities on seamounts but physical structure is still there (i.e. affect condition).	NO			NO	Unlikely that the extent/distribution will be impacted in a significant way by pressures.									
1	**Sea pen and burrowing megafaun-a communit-ies/ burrowed mud**	NO	Would have to be very extensive and heavy fishing. Plus habitat would be available for re-colonisation. Condition would be the more important thing to monitor.	NO	Would have to be very extensive and heavy fishing. Plus habitat would be available for re-colonisation. Condition would be the more important thing to monitor.		NO										

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2	***Serpula vermicularis* reefs**																
3	**Shallow tide-swept coarse sands with burrowing bivalves**	YES	Pressures: scallop dredging, section dredging, pollution, water quality.	YES		Survey data with groundtruthing; modelled data.	YES	More important for distribution that extent.									
1	***Spartina* swards (*Spartinion maritimae*)**	YES	Pressures: coastal development.	YES			NO	Would it be better to measure diversity within saltmarsh and just measure extent for saltmarsh in general?									
2	**Submarine structures made by leaking gases (to include "bubbling reefs" and "pockmarks" made up of carbonate structures)**	YES	Pressures: often coincident with fishing grounds – trawling.	YES	Rare, localised feature with a relatively small range, so relatively small changes in extent may result in a change in range and pattern.	Statutory Nature Conservation Bodies; Industry: offshore developments, oil and gas.	YES	Yes, but such small changes it might not be worth it.	NO	Possible for more prominent features but smaller features have been found by Cefas to be hard to detect by acoustic techniques.	YES	Possibly		Further studies required looking into the natural variability in the habitat and then feasibility study.			
3	**Submerged or partially submerged sea caves**	YES	Pressures: coastal defences. Is this sort of pressure sufficiently widespread?	YES		Survey data and information on developments.	YES	More important for extent than for distribution.									
1	**Subtidal chalk**	NO	Theoretical possibility (e.g. blasting) but in reality very unlikely.				NO										
2	**Subtidal mixed muddy sediments**																
3	**Sheltered muddy gravels**	YES	It is a highly localised habitat that occurs quite close to shore and can therefore be impacted by coastal activities.	YES		Survey data.	YES	Diverse communities –more important for distribution than for extent.									
1	**Tide-swept channels**	YES	Pressures: causeway construction.	YES	Less likely.		YES	Should be possible to identify physical barriers - more likely to be through desk- based study of licensed construction. Need to improve the definition.	YES	Problems with definition of habitat. Once this is sorted should be able to count how many there are.	YES	Count how many have been blocked by causeways - does this count as direct?		Improve habitat definition.			

		SESSION 2							SESSION 3						SESSION 4		
Group Number[5]	Habitat with an assessment and reporting requirement	Is the EXTENT of this habitat influenced by human pressures that we can measure (y/n)?	Comments	Is the DISTRIBUTION of this habitat influenced by human pressures that we can measure (y/n)?	Comments	What data sources are available in broad categories of data type for this habitat?	Is an extent/distribution indicator appropriate for this habitat?	Comments	Can we measure change in habitat extent/ distribution directly (y/n)?	Comments (Level of resolution/scale)	If not directly, can we opt for an indirect approach to measuring habitat extent/distribution (y/n)?	Comments (indirect approaches)	What methodologies/mapping activities are required to measure change in habitat extent/distribution?	Is there any potential R&D work that is required to measure change in habitat extent/distribution?	What baselines should we be using?	What baselines can be derived from our maps?	How do you detect real change in extent over time compared to change due to improved methods of measurement?
2	**Tide-swept algal communit-ies**																
3	**High-energy intertidal rock**	YES	Pressures: smothering, sedimentation. Intertidal habitats - high potential for loss of habitat.	YES		Survey data, modelled data; Environme-ntal Impact Assessme-nt and appropriate assessme-nts.	NO	Not appropriate for distribution; maybe for extent but it would be low priority.									
1	**Moderate energy intertidal rock**	NO	Theoretical possibility but in reality not that significant. Possible impact of barrages? But this should be picked up in estuarine rock.				NO										
2	**Low-energy intertidal rock**	YES	Pressures: coastal development - low energy is targeted over higher energy rock.	YES	Detailed pattern but not range	Mapped areas of coastal developm-ents on rock, Environme-nt Agency airborne remote sensing, Statutory Nature Conservati-on Bodies.	YES	But probably measured using areas of developments as a proxy.	YES		YES	Pressures as a proxy.	Model wave exposure on UK coastal rock (mapped using Phase I intertidal survey[10]). Overlay with map of developments.		Reference conditions - using past development footprint, a baseline map could be produced quite easily.	Easy to hind-cast the past reference condition for extent/distribution. Create a current extent map through fetch modelling (Burrows *et al*) and add to hind-casting.	Keep an eye on future footprints of pressures in the intertidal zone which will cause loss in extent/distribution.
3	**High-energy infralittor-al rock**	NO		NO			NO	Unlikely that the extent/distribution will be impacted in a significant way by pressures.									
1	**Moderate energy infralittor-al rock**	NO	Theoretical possibility but in reality not that significant.				NO										
2	**Low-energy infralittor-al rock**	NO	Very small scale, some near shore development, smothering.	NO		N/A	NO										
3	**High-energy circalittor-al rock**	NO		NO			NO	Unlikely that the extent/distribution will be impacted in a significant way by pressures.									

[10] Phase I Intertidal Survey was conducted by Natural Resources Wales and essentially mapped the entire coastline of Wales to provide a standard biological map of habitats in the intertidal zone.

		SESSION 2							SESSION 3						SESSION 4		
Group Number[5]	Habitat with an assessment and reporting requirement	Is the EXTENT of this habitat influenced by human pressures that we can measure (y/n)?	Comments	Is the DISTRIBUTION of this habitat influenced by human pressures that we can measure (y/n)?	Comments	What data sources are available in broad categories of data type for this habitat?	Is an extent/distribution indicator appropriate for this habitat?	Comments	Can we measure change in habitat extent/ distribution directly (y/n)?	Comments (Level of resolution/scale)	If not directly, can we opt for an indirect approach to measuring habitat extent/distribution (y/n)?	Comments (indirect approaches)	What methodologies/mapping activities are required to measure change in habitat extent/distribution?	Is there any potential R&D work that is required to measure change in habitat extent/distribution?	What baselines should we be using?	What baselines can be derived from our maps?	How do you detect real change in extent over time compared to change due to improved methods of measurement?
1	**Moderate energy circalittor-al rock**	NO	Theoretical possibility but in reality not that significant.				NO										
2	**Low energy circalittor-al rock**	NO	Very small scale, some near shore development, smothering.	NO		N/A	NO										
3	**Intertidal coarse sediment**																
1	**Intertidal mixed sediments**	YES	Pressures: coastal squeeze, coastal developments.				NO	Difficulty of defining habitat in reality. Might be more realistic to look at pressures. Might be better to look at broader habitats (e.g. intertidal sediments).									
2	**Shallow sublittoral coarse sediment**	YES	Pressures: aggregate extraction - much more pronounced at the sub-habitat level.	YES	At such a large scale - very detailed PATTERN might change but not RANGE.	BGS seabed sediment 1:250k maps, aggregate industry, Statutory Nature Conservati-on Bodies, Crown Estate.	YES	With sedimentary habitats there are always gradual changes between sediment types, not fixed boundaries. Easier to look at pressures as a proxy.	NO	Cannot distinguish between coarse sediment and some other sediment types.	YES	Perhaps a risk-based approach could be undertaken and pressures information used to state whether within a given predominant habitat type, a particular biotope is at risk of being lost >10%, or whichever threshold is chosen. If the risk is large or increasing, more monitoring could be implemented.	Grab sampling is the only good way of making the distinction.	Future methods might include video mosaics, although will probably still struggle to distinguish between coarse sediment and mixed sediment.			
3	**Shallow sublittoral mixed sediments**																

		SESSION 2							SESSION 3						SESSION 4		
Group Number[5]	Habitat with an assessment and reporting requirement	Is the EXTENT of this habitat influenced by human pressures that we can measure (y/n)?	Comments	Is the DISTRIBUTION of this habitat influenced by human pressures that we can measure (y/n)?	Comments	What data sources are available in broad categories of data type for this habitat?	Is an extent/distribution indicator appropriate for this habitat?	Comments	Can we measure change in habitat extent/ distribution directly (y/n)?	Comments (Level of resolution/scale)	If not directly, can we opt for an indirect approach to measuring habitat extent/distribution (y/n)?	Comments (indirect approaches)	What methodologies/mapping activities are required to measure change in habitat extent/distribution?	Is there any potential R&D work that is required to measure change in habitat extent/distribution?	What baselines should we be using?	What baselines can be derived from our maps?	How do you detect real change in extent over time compared to change due to improved methods of measurement?
1	**Shallow sublittoral sand**	NO	Issue of scale in terms of things like windfarm scour protection. Aggregate extraction can affect volume more than area. Not at any significant scale.				NO										
2	**Shallow sublittoral mud**	YES	Pressures: maintenance dredging, changes to hydrodynamic regime, associated with building, water supply, barrages, thickness reduced by trawling. Very localised.	NO		BGS seabed sediment 1:250k maps, aggregate industry, Statutory Nature Conservati-on Bodies, Crown Estate, fishing research agencies.	YES	But low priority. With sedimentary habitats there are always gradual changes between sediment types, not fixed boundaries. Easier to look at pressures as a proxy.	NO		YES		Predictive modelling using energy regime. Similar problems.	Future methods might include video mosaics, although will probably still struggle to distinguish between this and muddy sand.			
3	**Shelf sublittoral coarse sediment**																
1	**Shelf sublittoral mixed sediments**	NO	Scale issue. Loss at a significant scale is unlikely.				NO										
2	**Shelf sublittoral sand**	YES	Pressures: wind farms, aggregate extraction, permanent habitat loss due to developments.	YES	At such a large scale - very detailed PATTERN might change but not RANGE.	BGS seabed sediment 1:250k maps, aggregate industry, Statutory Nature Conservati-on Bodies, Crown Estate, fishing research agencies.	YES	Shallow/shelf distinction important. Naturally mobile in extent but not distribution.						Future methods might include video mosaics, although will probably still struggle to distinguish between this and sandy mud.			
3	**Shelf sublittoral mud**																
1	**Subtidal macrophy-te-dominated sediment**						NO	Not a useful habitat definition. Includes two different habitat types.									

		SESSION 2							SESSION 3						SESSION 4		
Group Number[5]	Habitat with an assessment and reporting requirement	Is the EXTENT of this habitat influenced by human pressures that we can measure (y/n)?	Comments	Is the DISTRIBUTION of this habitat influenced by human pressures that we can measure (y/n)?	Comments	What data sources are available in broad categories of data type for this habitat?	Is an extent/distribution indicator appropriate for this habitat?	Comments	Can we measure change in habitat extent/ distribution directly (y/n)?	Comments (Level of resolution/scale)	If not directly, can we opt for an indirect approach to measuring habitat extent/distribution (y/n)?	Comments (indirect approaches)	What methodologies/mapping activities are required to measure change in habitat extent/distribution?	Is there any potential R&D work that is required to measure change in habitat extent/distribution?	What baselines should we be using?	What baselines can be derived from our maps?	How do you detect real change in extent over time compared to change due to improved methods of measurement?
2	**Upper bathyal sediment**	NO		NO	Small effect of trawling on the pattern.	BGS seabed sediment 1:250k maps, aggregate industry, Statutory Nature Conservati-on Bodies, Crown Estate.	NO	Too broad.									
3	**Lower bathyal sediment**																
1	**Upper bathyal rock and biogenic reef**						NO	Need to separate biogenic reef from rock. For biogenic reef can have changes in extent and should be included.									
2	**Lower bathyal rock and biogenic reef**	YES	Pressures: Deep-water trawling - affects biogenic only	YES		JNCC, fishing industry	NO	Almost entirely based on the "biogenic" aspect of this habitat - but this is covered by *Lophelia pertusa* reef.									
3	**Abyssal sediment**																
1	**Abyssal rock and biogenic reef**						NO	Need to separate biogenic reef from rock. For biogenic reef can have changes in extent and should be included.									

6. Discussion and Next Steps

The workshop was the first to bring together a wide range of scientists, mapping specialists and the end-user MSFD community in order to inform the UK implementation of the MSFD.

Although indicators linked to spatial extent and distribution are theoretically useful for assessing Good Environmental Status (GES), it is clear that there are still many technical aspects of marine habitat mapping that still need to be resolved if meaningful cost-effective spatial indicators are to be developed.

Many of the technical aspects that need addressing surround issues of consistency, confidence and repeatability. Lessons from previous reporting requirements (e.g. Article 17 reporting 2013) show that there is an urgent need to address these technical issues if the UK is going to be able to distinguish between changes recorded in habitat extent/distribution due to improved data availability, differences in methodology, differences in definitions or real changes occurring (either naturally or due to anthropogenic pressures).

The marine scientific community have developed a number of initiatives over the years to address standardisation and calibration of methods. Issues addressed include equipment used to measure variables; standardisation in spatial and temporal resolution to inform comparisons; and consistency in interpretation of data (numerous papers have been published comparing model outputs for example). JNCC will be working with the HBDSEG Benthic Habitats Subgroup and the HBDSEG Seabed Mapping Group to identify the priority issues that need to be taken forward as a matter of urgency.

A combined approach needs to be developed by the JNCC Marine Indicators Group working together with the HBDSEG Benthic Habitats Subgroup, which will compile and ultimately synthesise all the criteria used by the three different groups in the workshop. The agreed combined approach should be used to undertake a final review of the habitats considered during the workshop, and to evaluate any remaining habitats in order to produce a final list of habitats for extent and/or distribution indicator development. This can then be incorporated into future R&D proposals for 2014/15 and beyond.

The scale and variety of UK benthic habitats makes any comprehensive direct mapping exercises prohibitively expensive (especially where there is need for repeat surveys for assessment). There is need therefore to develop a risk-based approach to develop priorities for information gathering.

The points of advice raised at this workshop, alongside the combined approach aforementioned, and the outputs from the revised list of habitats will be used to develop a prioritised list of actions to inform the next round of R&D proposals for benthic habitat indicator development in 2014/15. This will be done through technical discussions within JNCC and with the relevant HBDSEG subgroups. The preparation of recommendations by these groups should take into account existing work programmes, and also the limited resources available to undertake any further R&D work.

Annex A: Final Workshop Attendee List

No	Name	Organisation	Expertise
1	Matt Frost	Marine Biological Association	HBDSEG Benthic Habitats Subgroup Joint Chair and Sediment Lead
2	Bill Sanderson	Heriot-Watt University	HBDSEG Benthic Habitats Subgroup Joint Chair and Rock and Reefs Lead
3	Cristina Vina-Herbon	Joint Nature Conservation Committee	MSFD Senior Benthic Habitats Advisor
4	Becca Lowe	Joint Nature Conservation Committee	MSFD Benthic Habitats Advisor
5	Charlotte Johnston (Chair)	Joint Nature Conservation Committee	Head of Marine Monitoring & Mapping
6	Hayley Hinchen	Joint Nature Conservation Committee	Marine Assessment Scientist
7	Beth Stoker	Joint Nature Conservation Committee	Marine Assessment & Reporting Manager
8	Helen Ellwood	Joint Nature Conservation Committee	Marine Mapping Scientist
9	Francesca Marubini	Joint Nature Conservation Committee	Marine Monitoring Strategy Manager
10	Karen Robinson	Natural Resources Wales	Marine Ecologist (HABMAP)
11	Kirsten Ramsay	Natural Resources Wales	Senior Subtidal Ecologist (HABMAP)
12	Koen Vanstaen	Centre for Environment Fisheries and Aquaculture Science	Senior Habitat Mapper
13	Roger Coggan	Centre for Environment Fisheries and Aquaculture Science	Senior Habitat Mapper
14	Sue Ware	Centre for Environment Fisheries and Aquaculture Science	Benthic ecologist
15	Chris Jenkins	Centre for Environment Fisheries and Aquaculture Science	Benthic ecologist
16	Chris Pirie	Natural England	Senior Marine Specialist (Marine Evidence)
17	Mike Young	Natural England	Marine Adviser
18	Andrew Colenutt	New Forest District Council	Marine Habitat Mapping
19	Tim Le Bas	National Oceanography Centre	Sonar Processing, Seafloor Mapping
20	Jacques Populus	Ifremer	MESH, EUSeaMap – Habitat Mapping (predictive modelling)
21	Nils Piechaud	Plymouth University	Deep Sea Modelling/Habitat Mapping
22	Peter Hayes	Marine Scotland Science	Offshore Energy Environmental Manager
23	Duncan Hume	Marine Management Organisation	Data Manager
24	Jayne Fitch	Environment Agency	Benthic Specialist
25	Graham Phillips	Environment Agency	Benthic Specialist
26	Carole Kelly	Department for Environment Food and Rural Affairs	Marine Biodiversity R&D Programme Manager
27	Bryony Pearce	Marine Ecological Surveys Ltd.	Leader of the baseline/reference conditions contract we ran in 2012

Annex B: Workshop Programme

Day 1	
09:00 – 09:30	**Tea/Coffee**
09:30 – 10:45 **09:30 – 09:40** **09:40 – 09:45** **09:45 – 10:05** **10:05 – 10:15 (+5mins)** **10:20 – 10:40 (+5mins)**	**SESSION 1: Overview Presentations** **Introduction:** Welcome (Charlotte Johnston, JNCC) Workshop Aims and Objectives (Cristina Herbon, JNCC) Brief Introduction to the MSFD (Cristina Herbon, JNCC) **Overview of the MSFD spatial extent and distribution proposed indicators and targets** (Matt Frost, MBA) **Current spatial data products and their limitations** (Helen Ellwood, JNCC)
10:45 - 11:00	**Tea/Coffee**
11:00 – 13:00 **11:00 – 11:15** **11:15 – 11:30 (+10mins)** **11:40 – 13:00**	**SESSION 2 – Can extent and distribution be defined for particular habitats/biotopes?** **Case Studies: Current needs and ways of measuring extent/distribution** • EC Habitats Directive: Assessing the area parameter of Favourable Conservation Status (Beth Stoker, JNCC) • Mapping the extent of marine features in Wales (Karen Robinson, CCW) **Break-out group discussion: Using the rationalised list of habitats, identify and define potential habitat extent/distribution indicators** Some potential guiding questions to consider: • Which habitats are suitable for an indicator of extent/distribution? • What data sources are available in broad categories of data type for particular habitats and/or biotopes? • Is an extent/distribution indicator feasible for particular habitats and/or biotopes? • Is there a difference between extent and distribution requirements?
13:00 – 14:00	**LUNCH**
14:00 – 15:00	**Plenary – Session 2** Discussion of issues raised by groups during Session 2. **Session 2 Outcomes:** Develop a series of recommendations on: • whether/how extent and distribution can be defined for particular habitats/biotopes By establishing: • which habitats/biotopes are suitable for an indicator of extent/distribution • what current mapping data are available to support these indicators • the feasibility of indicators of extent/distribution for the suitable habitats/biotopes.
15:00 – 15:15	**Tea/Coffee**
15:15 – 17:00 **15:15 – 15:35 (+5mins)** **15:40 – 17:00**	**SESSION 3 – How can we measure change in habitat extent and distribution indicators?** **Case Study:** Development of spatial assessment of rocky reefs/biogenic structures (Bill Sanderson, Heriot-Watt University) **Break-out group discussion: How can we measure change in habitat extent and distribution indicators?** Some potential guiding questions to consider: • Can we measure change in habitat extent/distribution directly? • If able to, identify what habitat classification resolution may be required. • If not directly, can an indirect approach be used to measure habitat extent/distribution? • What methodologies/mapping activities are required to measure change in habitat extent/distribution? • Is there any potential R&D work that is required to measure change in habitat extent/distribution?

DAY 2	
09:00 – 09:15	**Tea/Coffee**
09:15 – 10:15	**Plenary – Session 3** Discussion of issues raised by groups during Session 3. **Session 3 Outcomes:** Develop a series of recommendations on: • how we can measure change in habitat extent/distribution indicators directly or indirectly By establishing: • whether/how we can measure change in habitat extent/distribution (e.g. via measuring habitat loss) • what level of resolution/habitat classification is required for the analysis of habitat data • what potential R&D work is required for each relevant habitat to fully develop these indicators.
10:15 – 10:35 **10:15 – 10:30 (+5mins)**	**SESSION 4 – Baselines and reference conditions** **Case Study:** Methods for determining reference conditions for habitat extent and distribution (Bryony Pearce, Gardline Caledonia Ltd)
10:35 - 10:50	**Tea/Coffee**
10:50 – 12:15	**SESSION 4 – Break-out group discussion: how baselines should be used for potential habitat extent/distribution indicators** Some potential guiding questions to consider: • What baselines should we be using? • How do you detect real change in extent over time compared to change due to improved methods of measurement?
12:15 – 13:15	**Plenary – Session 4** Discussion of issues raised by groups during Session 4. **Session 4 Outcome:** Develop a series of recommendations on how baselines should be used for potential habitat extent/distribution indicators and suggestions for filling gaps in knowledge.
13:15 – 13:30	**Round-up**
13:30 – 14:00	**LUNCH**

Annex C: Marine Strategy Framework Directive – Background Document

Introduction

This document was written for the participants in the MSFD Benthic Indicators Workshop: *Potential use of mapped extent and distribution of habitats as indicators of GES* (21-22 March 2013). It provides some background information on the MSFD, an overview of the relevant information contained within the Marine Strategy Part One, and information on extent and distribution indicators for benthic habitats.

Background

Policy Context

The Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC) was formally adopted by the European Union in July 2008. It forms the environmental pillar of the EU's Integrated European Maritime Policy and compliments the economic and social aspects of this policy. The MSFD outlines a transparent, legislative framework for an ecosystem-based approach to the management of human activities which supports the sustainable use of marine goods and services. The overarching goal of the Directive is to achieve 'Good Environmental Status' (GES) by 2020 across Europe's marine environment. GES is defined as '*the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations*'.

The Directive sets out eleven descriptors as the basis to determine GES:

1. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
2. Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
3. Populations of commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
4. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
5. Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.
6. Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
7. Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
8. Concentrations of contaminants are at levels not giving rise to pollution effects.
9. Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
10. Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
11. Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

In order to achieve GES in a coherent and strategic manner, the Directive establishes four European Marine Regions (Article 4), based on geographical and environmental criteria.

Marine strategies are being developed by Member States (MS) to protect and conserve the marine environment, prevent its deterioration, and, where practicable, restore marine ecosystems in areas where they have been adversely affected. Although the strategies should be specific to the waters of the MS, they should also reflect the overall perspective of the marine region or sub-region, as GES is assessed at the sub-regional scale.

The marine strategies must contain:

- An initial assessment of the current environmental status of that MS's marine waters (Art. 8);
- A determination of what Good Environmental Status means for those waters (Art. 9);
- Targets and indicators designed to show whether a MS is achieving GES (Art. 10);
- A monitoring programme to measure progress towards GES (Art. 11);
- A programme of measures designed to achieve or maintain GES (Art. 13).

MS's are not required to take specific steps where there is no significant risk to the marine environment, or where costs would be disproportionate taking account of the risks to the marine environment, provided that any decision not to take action is properly justified. The Directive does not describe a specific programme of measures that Member States should adopt to achieve GES, except for the establishment of spatial protection measures, contributing to a network of Marine Protected Areas (MPAs).

Under Article 10 of the Directive there is a requirement for each MS to establish targets and indicators designed to guide progress towards achieving GES and taking account of the continuing application of relevant existing environmental targets laid down at a national, community and international level in respect of the same waters. The Commission Decision of September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU) describes the criteria and indicators for each MSFD descriptor for which MS's must develop suitable operational indicators and targets.

See the following references for further background information and policy context:

Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU)
(http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF)

Task Group 1 report on Biological diversity (2010)
Cochrane, S.K.J., Connor, D.W., Nilsson, P., Mitchell, I., Reker, J., Franco, J., Valavanis, V., Moncheva, S., Ekebom, J., Nygaard, K., Serrão Santos, R., Naberhaus, I., Packeiser,T., van de Bund, W. and Cardoso, A.C. (2010). Marine Strategy Framework Directive. Guidance on the interpretation and application of Descriptor 1: Biological diversity. Report by Task Group 1 on Biological diversity for the European Commission's Joint Research Centre, Ispra, Italy.
(http://www.ices.dk/projects/MSFD/TG1final.pdf)

OSPAR MSFD Advice manual on biodiversity (2012)
OSPAR, 2012. MSFD advice manual on biodiversity. Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptors 1, 2, 4 and 6.
(http://www.ospar.org/documents/dbase/publications/p00581_advice%20document%20d1_d2_d4_d6_biodiversity.pdf)

GES characteristics, targets and indicators

In 2012, the UK produced Part One of the Marine Strategy, containing information on the initial assessment, the characteristics of GES, and associated targets and indicators for each of the GES descriptors.

The characteristics of GES provide a high-level, qualitative description of what the marine environment will look like when GES is achieved. The GES characteristics have been developed by policy makers in consultation with experts and key stakeholders. The most relevant Descriptor for the work to be undertaken within this workshop is Descriptor 1 – Biological diversity. The UK characteristics of GES submitted in the strategy for D1 are:

'At the scale of the MSFD sub-regions, and in line with prevailing conditions[11], the loss of biodiversity[12] has been halted[13] and, where practicable, restoration is underway':

- The abundance, distribution, extent and condition of species and habitats in UK waters are in line with prevailing environmental conditions as defined by specific targets for species and habitats.
- Marine ecosystems and their constituent species and habitats are not significantly impacted by human activities such that the specific structures and functions for their long-term maintenance exist for the foreseeable future.
- Habitats and species identified as requiring protection under existing national or international agreements are conserved effectively through appropriate national or regional[14] mechanisms.'

The GES targets and indicators are built on the high-level GES characteristics as described above for Descriptor 1, providing a more detailed, quantitative assessment framework for guiding progress towards GES. The GES targets and indicators were developed on the basis of advice from experts in the UK Marine Monitoring and Assessment Strategy (UKMMAS) Healthy and Biologically Diverse Seas Evidence Group (HBDSEG), facilitated by JNCC. The targets and indicators were organised according to six ecosystem components: three species groups (fish, birds, marine mammals), and three habitats groups (pelagic habitats, sediment habitats, rock and biogenic reef habitats).

Targets relevant for discussion on extent and distribution indicators are those submitted under Descriptor 1 – Biological diversity (Table C1). However, due to uncertainties on the current and desired state and a significant lack of evidence, it has not always been possible to establish target thresholds. As a result, a combination of qualitative contributions and quantitative targets has been used to determine GES. For listed sediment habitats, and rock and biogenic reef habitats, the targets are all based on existing targets under the Habitats Directive. For sediment habitats not protected by existing legislation (known as predominant sediment habitats) new targets have been developed; mainly trend-based pressure targets, requiring a reduction in damaging human impacts on these habitats.

Experts have also developed a range of more detailed indicators, including those already being used as part of existing monitoring programmes. The full list can be found in Annex A of the UK Marine Strategy Part One.

[11] Prevailing conditions are defined as "in accordance with the intrinsic physiographic and climatic conditions of the different geographic regions". Prevailing conditions are understood to include climatic changes caused by human induced climate change. Prevailing conditions (including climatic changes) will need to be monitored in order for a full assessment of progress towards GES to be carried out and targets will need to be revised if prevailing conditions change in such a way as to make them no longer relevant or achievable.

[12] According to the Convention on Biological Diversity (CBD), biodiversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

[13] CBD Target 12 "By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained@

[14] The term 'regional' refers to the scale of the regions and subregions in the Directive e.g. the Greater North Sea.

Table C1: GES targets for benthic habitats included in the Marine Strategy Part One relevant for Descriptor 1.

Rock & Reef targets - Habitat distribution	At the scale of the MSFD sub-regions rock and biogenic reef habitats are stable or increasing: For all listed (special) and predominant habitat types range and distribution are stable or increasing and not smaller than the baseline value (Favourable Reference Range[15] for Habitats Directive habitats).
Rock & Reef targets - Habitat extent	At the scale of the MSFD sub-regions rock and biogenic reef habitats are stable or increasing: For all listed (special) and predominant habitat type's area is stable or increasing and not smaller than the baseline value (Favourable Reference Area for Habitats Directive (HD) habitats).
Sediment targets - Habitat distribution	*Predominant habitat types:* No target proposed – see target below for Criterion 1.6. *Listed (special) habitat types:* At the scale of the MSFD sub-regions the range and distribution of listed (special) sediment habitat types is stable or increasing and not smaller than the baseline value (Favourable Reference Range for HD habitats)
Sediment targets - Habitat extent	*Predominant habitat types:* No target proposed – see target below for Criterion 1.6. *Listed (special) habitat types:* At the scale of the MSFD sub-regions the area of listed (special) sediment habitat types is stable or increasing and not smaller than the baseline value (Favourable Reference Area for Habitats Directive habitats). WFD extent targets for saltmarsh and seagrass should be used within WFD boundaries as appropriate.
Sediment targets - Habitat condition; Physical damage; Condition of the benthic community	*Predominant habitat types:* At the scale of the MSFD sub-regions damaging human impacts on predominant sediment habitats are reduced: The area of habitat which is unsustainably impacted by human activities (as defined by vulnerability criteria) is reduced and the precautionary principle is applied to the most sensitive habitat types and/or those which are most important for ecosystem functioning. *Listed (special) habitat types:* At the scale of the MSFD sub-regions the area of special (listed) sediment habitat types below GES (i.e. unacceptable impact/unsustainable use) as defined by condition indicators must not exceed 5% of baseline value (favourable reference area for Habitats Directive habitats). WFD targets (km2 thresholds) for area of unacceptable impact for benthic invertebrates, macroalgae, saltmarsh and seagrass should be used within WFD boundaries as appropriate.

Identifying indicators for benthic habitats

The UK Department for Environment, Food and Rural Affairs (Defra), on behalf of the Devolved Administrations (DAs), requested that HBDSEG develop options for GES targets and indicators for the three biodiversity descriptors, specifically Descriptors 1, 4 and 6. In August 2011, HBDSEG produced advice to Government on these targets and indicators (Moffat *et al.* 2011[16]), drawing, where possible, on existing targets and indicators in use under other Directives and Conventions. The advice contained within Moffat et al, used the European Commission Decision of September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU) as a basis for structuring the targets and indicators required. Table C2 shows the Commission Decision criteria and indicators which are relevant to benthic habitats. An indicator is considered to be a variable which supplies information on other variables that are difficult to access and can be used to take a decision. Indicators enable us to understand a complex system and distil it into its most important aspects.

[15] Favourable Reference Range is part of the assessment of Favourable Conservation Status under the Habitats Directive.

[16] Moffat, C, Aish, A., Hawkridge, J.M., Miles, H., Mitchell, P. I., McQuatters-Gollop, A., Frost, M., Greenstreet, S., Pinn, E., Proudfoot, R., Sanderson, W. G., & Tasker, M. L. (2011). Advice on United Kingdom biodiversity indicators and targets for the Marine Strategy Framework Directive. *Healthy and Biologically Diverse Seas Evidence Group Report to the Department for Environment, Food and Rural Affairs.* 210pp.

Table C2: Descriptors, criteria and indicators from Commission Decision 2010/477/EU for which advice on targets and indicators was provided for benthic habitats (the criteria and indicators, which could be relevant for this workshop are shown in **bold** typeface).

Descriptor	Criterion	Indicator
1 (Biological diversity)	**1.4 Habitat distribution**	**1.4.1 Distributional range**
		1.4.2 Distributional pattern
	1.5 Habitat extent	**1.5.1 Habitat area**
		1.5.2 Habitat volume, where relevant
	1.6 Habitat condition	1.6.1 Condition of the typical species and communities
		1.6.2 Relative abundance and/or biomass, as appropriate
		1.6.3 Physical, hydrological and chemical conditions
6 (Sea floor integrity)	6.1 Physical damage, having regard to substrate characteristics	6.1.1 Type, abundance, biomass and areal extent of relevant biogenic substrate
		6.1.2 Extent of the seabed significantly affected by human activities for the different substrate types
		6.2.1 Presence of particularly sensitive and/or tolerant species
	6.2 Condition of benthic community	6.2.2 Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species
		6.2.3 Proportion of biomass or number of individuals in the macrobenthos above some specified length/size
		6.2.4 Parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community

Many of the targets and indicators proposed by HBDSEG, especially for benthic habitats, are however not yet defined, validated or operational. In this context, the term **'defined'** means that the indicator scope, scale and metrics to be measured have been identified. The term **'validated'** means that the indicator has been tested to demonstrate that it actually works i.e. it can detect an impact that is known to be occurring, it is responding to the pressure that you are interested and it is possible to measure the change. This validation step requires data. Subsequently, an indicator becomes **'operational'** when appropriate monitoring, quality standards and a process for disseminating the results is in place (Moffat *et al.,* 2011). Therefore, in order to incorporate these proposed benthic habitats indicators into the next MSFD reporting round; they need to be made fully operational (ideally) by 2014 so that they can be included in the future monitoring programme. In order to achieve this goal, considerable research and development work is needed in order to firstly define and validate the indicators before suitable monitoring is put in place. As such, a research and development (R&D) work programme has been identified by HBDSEG which will aim to fully operationalise priority indicators for the MSFD biodiversity descriptors (as defined above).

Marine sub-regions in UK waters

The North East Atlantic Marine Region is divided into four subregions, with UK waters lying in two of these (the Greater North Sea and the Celtic Seas, see Figure C1). Each Member State is required to develop a marine strategy for their waters (EEZs or extended Continental Shelf areas), in coordination with other countries within the same marine region or subregion. This coordination is to be achieved through the Regional Seas Conventions, which for the UK is the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (www.ospar.org).

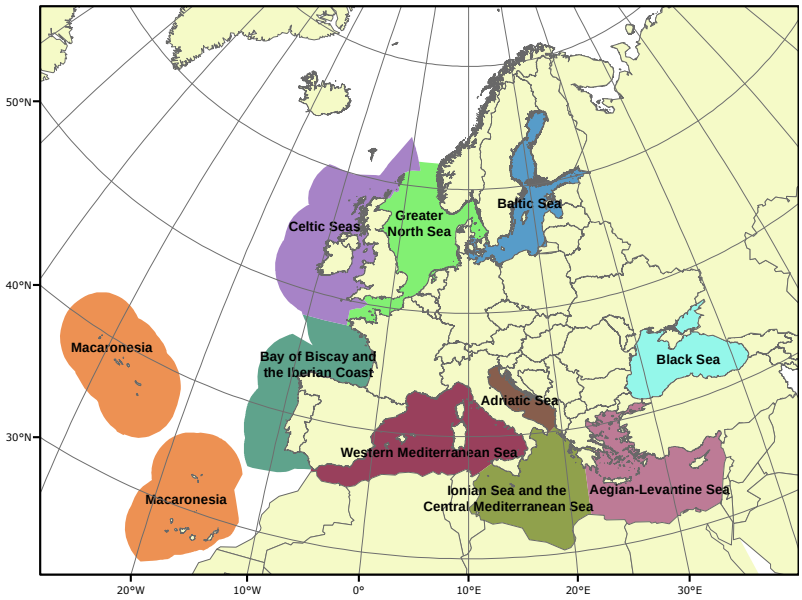

Figure C1: Final draft map of MSFD marine regions and sub-regions. For the North-East Atlantic region, outer boundaries are indicated for the sub-regions listed in the Directive, without addressing the remaining parts of the overall OSPAR marine region (e.g. waters in the Iceland Sea, Norwegian Sea and Barents Sea). For the purpose of this map, all Exclusive Economic Zone (EEZ) boundaries shown are indicative only and are subject to an on-going consultation with Member States. The areas currently shown follow the boundaries of EEZ or other maritime zones where Member States (MS) exercise sovereign rights or jurisdiction (such as fisheries zones). In addition, in relation to the seabed and subsoil, it will be necessary to consider the full extension of the continental shelf, in cases where a submission has been submitted to the UN Commission on the Limits of the Continental Shelf for the delimitation of the boundaries of the continental shelf (Source for EEZ: http://www.vliz.be/vmdcdata/marbound/download.php).

Annex D: Current spatial data products

Introduction

This document was written for the participants in the MSFD Benthic Indicators Workshop: *Potential use of mapped extent and distribution of habitats as indicators of GES* (21-22 March 2013). It summarises information available about seabed habitat mapping in the UK, providing signposts to further information about standards and protocols for data collection, and existing national spatial data products.

Data collection techniques

The information provided below is intended for participants of the workshop who wish to delve into the details of techniques used for making habitat maps from survey data. There will not be further discussion of the relative merits of these techniques at the workshop. For participants requiring a basic introduction to how habitat maps are made, please refer to http://www.searchmesh.net/default.aspx?page=1658. As part of the MESH project (2004-2008), existing standards and protocols for seabed habitat mapping were reviewed. The review was led by international experts in the MESH partner organisations, and was approved by ICES Working Groups and OSPAR Committees. The aim of this Review of Standards and Protocols was to highlighting the standards that could be adopted immediately, and identify the major areas where further development was required. The Review covers:

1. Remote sensing techniques for shoreline & shallow water surveys e.g. airborne techniques including LiDAR, CASI and aerial photography, satellite imaging, shoreline surveys and ground-truth sampling.
2. Remote sensing techniques for deeper water surveys e.g. using acoustic systems such as multi-beam sonar, side-scan sonar, Acoustic Ground Discrimination Systems and 3D seismic systems, optical techniques including camera sledges, remotely operated vehicles (ROVs), drop cameras and sediment profile imagery.
3. In-situ sampling for ground-truthing of remote data e.g. by diver surveys, grab and core samplers, and trawls dredges.

A copy of this Review of Standards and Protocols for Seabed Habitat Mapping (Coggan *et al.* 2007) can be downloaded from http://www.searchmesh.net/default.aspx?page=1442.
As a result of this Review, it became apparent that organisations were using the same survey equipment in slightly different ways. Surveyors often adapt survey techniques to be used for a different purpose to that for which the survey technique was originally developed. To try and achieve some standardisation in the use of survey equipment, the MESH Project drafted a series of Recommended Operating Guidelines (ROGs) to describe how best to use each technique in a seabed habitat mapping context. Where standard operating procedures, ISO-standards or similar are well known and recognised, references and links are made. The ROGs cover four main areas:

- **Guidelines for mapping intertidal and shallow subtidal habitats by remote and on-site surveys**, showing how to collect, manage and verify data.
- **Standards and protocols for the use and ground-truthing of remote sensing imagery**, both satellite and aerial (e.g. SPOT, CASI and LiDAR).
- **Guidelines for mapping deeper sub-tidal habitats (e.g. 20 – 200 m depths) by remote and on-site surveys**, showing how to collect, manage and verify data.
- **Standards and protocols for the use and ground-truthing of acoustic techniques** (e.g. side-scan sonar, multi-beam sonar, Acoustic Ground Discrimination Systems **and their associated ground-truthing methods** (e.g. underwater video, and sediment sampling).

The currently available ROGs are listed below, hyperlinked to .pdf files on the MESH website for each:

- 3D seismic derived seabed imagery
- Aerial photography
- Acoustic Ground Discrimination System
- Airborne digital imagery
- Box Coring
- LiDAR (MESH Atlantic update, 2012)
- High resolution satellite imagery
- Sediment Profile Imagery
- Side-scan
- Single beam echosounder
- Sub Bottom Profiler (Chirp)
- Swath Bathymetry
- Trawls & Dredges
- Underwater video & photographic imagery

It is clear that in some of these areas, technology has moved on since these ROGs were written 6-8 years ago. Therefore the MESH Atlantic project has undertaken work to update some of these documents. The updated LiDAR ROG is included above, and further updates are expected, including a new ROG for grab sampling. Currently this set of guidelines represents the best-practice standards for seabed habitat mapping in UK waters and have been widely promoted as such. Since 2007, surveyors collecting seabed habitat mapping data for the purposes of nature conservation have endeavoured to follow these standards. All of these ROGs form part of the MESH Guide to Habitat Mapping (www.searchmesh.net/mappingguide), which provides extensive advice on the topic, answering questions under six broad sections:

- What is habitat mapping?
- What do I want to map?
- How do I collect my data?
- How do I make a map?
- How good is my map?
- What can I do with my map?

Existing spatial data products

EUNIS composite map

The EUNIS composite habitat map is a combination of all available habitat maps in the UK derived from surveys, converted to a standard format (e.g. coordinate system, attributes) and translated into the EUNIS (version 2007-11) classification. The EUNIS composite map is available for viewing and download on the MESH webGIS[17].This is used as the base dataset from which JNCC derive other maps such as those for Habitats Directive Annex I habitats and OSPAR priority habitats, described below.

The composite habitat map started as an output of MESH, showing EUNIS habitat types in north-west Europe, based on all the existing habitat maps collated by MESH Partners in the five countries. Since the MESH project ended in 2008, JNCC has continued to update the composite map with new data for UK waters as well as for other countries (through the

[17] http://www.searchmesh.net/default.aspx?page=1974&&mapInstance=MESHAtlanticMap_&X=-5.7447&Y=55.6554085&Zoom=4&Layers=Eunis

MESH Atlantic project, 2011-2013). The last update to the UK map was in November 2012 (Figure D1). Please note this map does not include the latest maps being produced as part of the MPA site verification and data collection surveys. The next update is planned for autumn 2013. Some facts about the EUNIS composite map are given in Table D1.

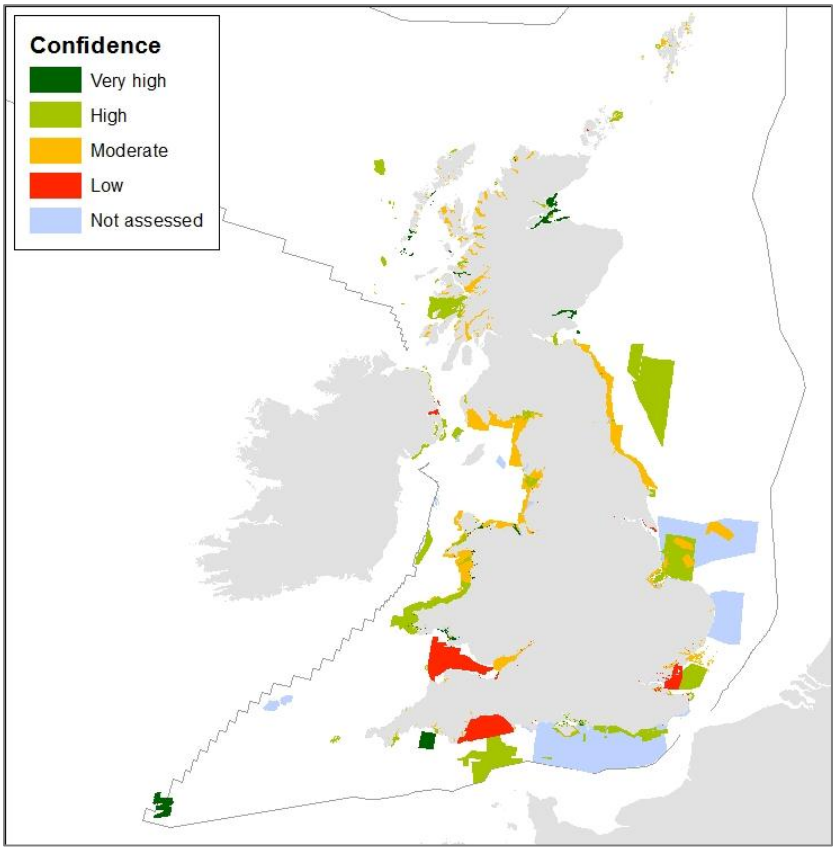

Figure D1: Habitat mapping study areas, as of November 2012.

Table D1: Facts about the EUNIS composite map

Number of habitat maps	189
Proportion of UK continental shelf waters covered by habitat maps	10 %
Range of map ages	1980 to 2012
Range of confidence scores	24 to 91 %
Range of classification resolutions	EUNIS levels 2 to 6

If all the maps were simply combined and loaded into a desktop GIS or an online mapping system such as the MESH webGIS, map queries would return multiple results in overlapping areas. Often, the polygons queried suggested different habitat types were present for the same area. To avoid such confusion it was necessary to select which study should take precedence when creating the single layer. The quality of each habitat map was evaluated using the MESH confidence assessment system[18]. This multi-criteria system was developed by the MESH Partnership to give users some measure of the suitability of habitat maps for management uses. Where maps overlapped, the map with the highest confidence rating was used to create the single map layer. In cases where there were overlapping habitat maps that had identical confidence ratings, the map showing the greatest level of habitat detail was chosen for the single layer.

[18] http://www.searchmesh.net/default.aspx?page=1635

A map showing the confidence assessment scores is also displayed on the MESH webGIS[19], allowing users to make a judgement about the suitability of habitat maps for their intended purpose. In addition to a visual representation of overall confidence of studies, users can also access the scores that contributed to the overall confidence score for each habitat map. The confidence evaluation process addresses three main questions:

1. How good is the remote sensing?
2. How good is the ground truthing?
3. How good is the data interpretation?

These questions were selected because MESH promoted the creation of habitat maps through the interpretation of remote sensing data *and* ground truthing data.

Habitats Directive Annex I maps

JNCC has prepared composite maps of Habitats Directive Annex I habitats occurring in UK waters for:

- Reefs
- Sandbanks which are slightly covered by seawater all the time
- Submarine structures made by leaking gases
- Mudflats and sandflats not covered by seawater at low tide

In addition, composite maps have been prepared for the Habitats Directive Annex I features that based on topographic features:

- Coastal lagoons
- Estuaries
- Large shallow inlets and bays
- Sea caves

All these maps have been recently updated as part of reporting under Article 17 of the Habitats Directive and new versions will soon be updated on the UK MPA webGIS (jncc.defra.gov.uk/page-5201).

Reefs

Previous maps of reef habitat around the UK showed the potential extent of the habitat; it is now the case that in many areas, there is enough confidence in the data to refer to them as high confidence reef, for which special areas of conservation (SACs) are designated. Broadly, Broadly, areas mapped as high confidence reef (see
Figure D2) are a result of surveys that used a combination of remote sensing and ground truthing and/or were specifically designed to identify Annex I habitats. Areas mapped as potential reef are a result of broad-scale surveys or interpolation of disparate sample points, where further work may be needed to delineate the precise boundaries of the habitat. Where there is enough evidence from other sources, SACs are also designated for areas containing only potential reef.
A third layer has also been created, which shows areas known not to contain reef – this is to help distinguish between areas that have not been adequately mapped and/or interpreted and areas that have been found to contain other habitats. Further information describing the data sources and processes involved in creating distribution maps of Annex I reefs in UK waters can be found at:
http://jncc.defra.gov.uk/pdf/20110110_AnnexI_Reef_Map_Methodology_v1.0.pdf

[19] http://www.searchmesh.net/default.aspx?page=1974&&mapInstance=MESHAtlanticMap_&X=-5.7447&Y=55.6554085&Zoom=4&Layers=TransHabConfidence

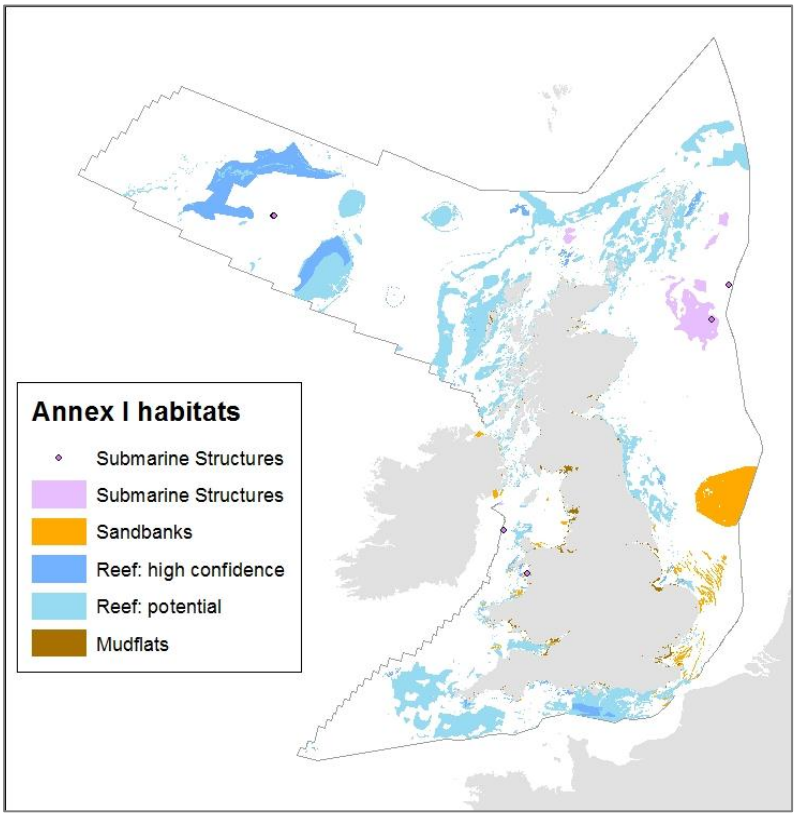

Figure D2: Annex I habitats, as of January 2013.

Sandbanks which are slightly covered by seawater all the time

Previous maps showed areas of sandy sediment that may potentially be Annex I sandbanks based on sediment type and a broad depth range. It is now the case that in some areas, there is enough sediment data and bathymetry of a high enough resolution to identify sandbanks that are topographically distinct from the surrounding seabed, thereby increasing the precision of the sandbanks dataset. The definition of Annex I sandbanks was refined in 2007 (CEC, 2007) to only include areas of sandy sediment that are topographically distinct from the seabed; however, the previous, broader definition (CEC, 2003) must be retained in mapping sandbanks in areas where Special Areas of Conservation have been designated before the definition revision. Therefore the available map (see Figure D2) shows a combination of topographically distinct sandbanks combined with sandy areas that meet the broader definition of Annex I sandbank habitat.

Submarine structures made by leaking gases

This map (see Figure D2) shows the location of known Annex I submarine structures made by leaking gases. It also shows areas where gas seeps are known to occur and therefore where there may be additional submarine structures that have not yet been found. Through offshore survey, JNCC is working to confirm the presence of Annex I submarine structures in these areas and to identify those sites which merit selection as SACs.

Mudflats and sandflats not covered by seawater at low tide

Akin to the mapping of reefs, Annex I mudflats (see Figure D2) are mapped as either high confidence or potential mudflats. Broadly, areas mapped as high confidence mudflats are a result of surveys that used a combination of remote sensing and ground truthing and/or were specifically designed to identify Annex I habitats. Areas mapped as potential mudflats tend to

be a result of broad-scale surveys, where further work may be needed to delineate the precise boundaries of the habitat.

OSPAR and other listed habitat maps

A correlation table has been produced to assist with the translation of EUNIS habitat types to OSPAR threatened and/or declining (T&D) habitats in the Northeast Atlantic (amongst other correlations). A .pdf version of this table is available on the JNCC website[20]. The correlation table is used to extract areas from the EUNIS composite map where habitat types equivalent to the OSPAR T&D habitats have been recorded and mapped. In addition, point sample data from JNCC's Marine Recorder database is used in a similar translation process, to maximise the number of records available (relatively few polygons have been mapped which correspond to OSPAR T&D habitats) (see Figure D3).

However, the original UK marine habitat classification system, on which the marine part of EUNIS is based, was developed before many of the legislative instruments that specify listed habitats came into force. It is clear the correlation tables need to develop along with new obligations. In some cases one JNCC habitat type is equivalent to a listed habitat (e.g. EUNIS 'littoral mud' is equivalent to OSPAR priority habitat 'intertidal mud' with a 1:1 relationship), and in other cases several EUNIS habitat types would be combined to identify a listed habitat (e.g. all habitat types mentioning *Sabellaria* combined to map *Sabellaria* reef) – i.e. a many:1 relationship.

Unfortunately some listed habitats can only be partially matched for a number of reasons. Some examples of these are provided below.

- Listed habitat can occur in deeper waters, or different biological zones, than those defined in the current Marine Habitat Classification for Britain and Ireland (Connor *et al.* 2004): cold water corals, sponges and sea-pens.E.g. A biotope map following the UK classification system could not define any habitat types deeper than about 200m as that is the deepest limit given in habitat type descriptions[21]
- Listed habitat can occur on several substrate types, but a habitat type is only defined in EUNIS with one type of substrate: cold water corals, sponges, oyster beds. E.g. A biotope map may show areas of 'Deep sponge communities on circalittoral rock' (CR.HCR.DpSp), but areas of coarse sediment with sponges would just be defined as 'Circalittoral coarse sediment' as no sponge habitat types are available in the JNCC Classification for that substrate. Listed habitat is a topographic feature or geological feature and therefore cannot be inferred from maps showing different habitat types: seamounts, carbonate mounds.

[20] http://jncc.defra.gov.uk/pdf/EUNIS_Correlation_2007-11_20101206v2.pdf (an excel spreadsheet can also be requested)
[21] Note that EUNIS does include a deep sea section (under review) whereas the UK version of the classification does not.

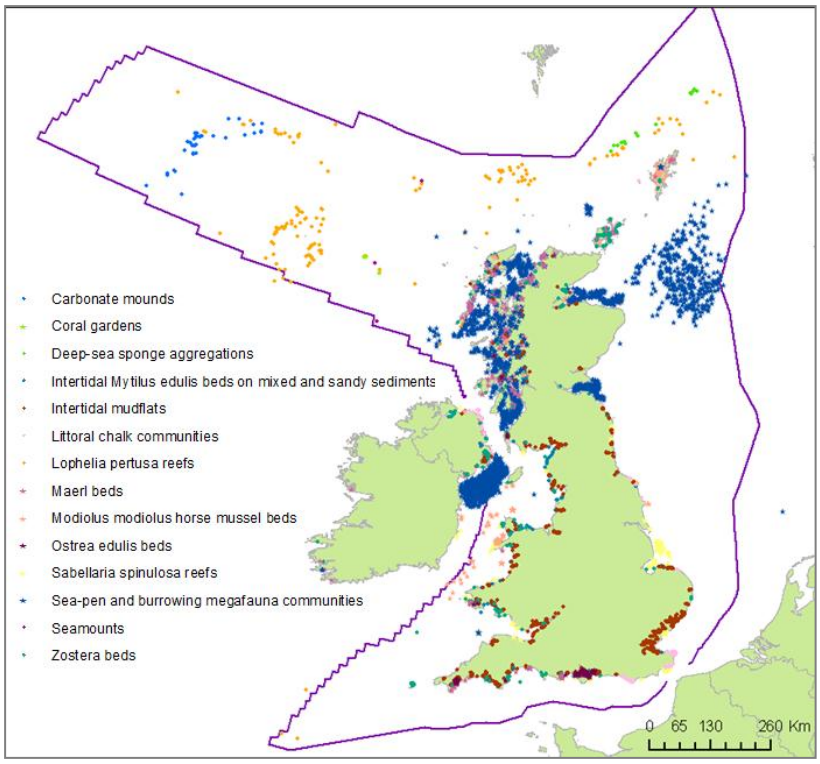

Figure D3: OSPAR threatened and/or declining habitats.

Predictive seabed habitat mapping products: EUSeaMap & UKSeaMap 2010

EUSeaMap[22] (Cameron and Askew, 2011) and UKSeaMap 2010[23] (McBreen et al, 2011) are two recently completed predictive seabed mapping projects led by JNCC (Figure D4).

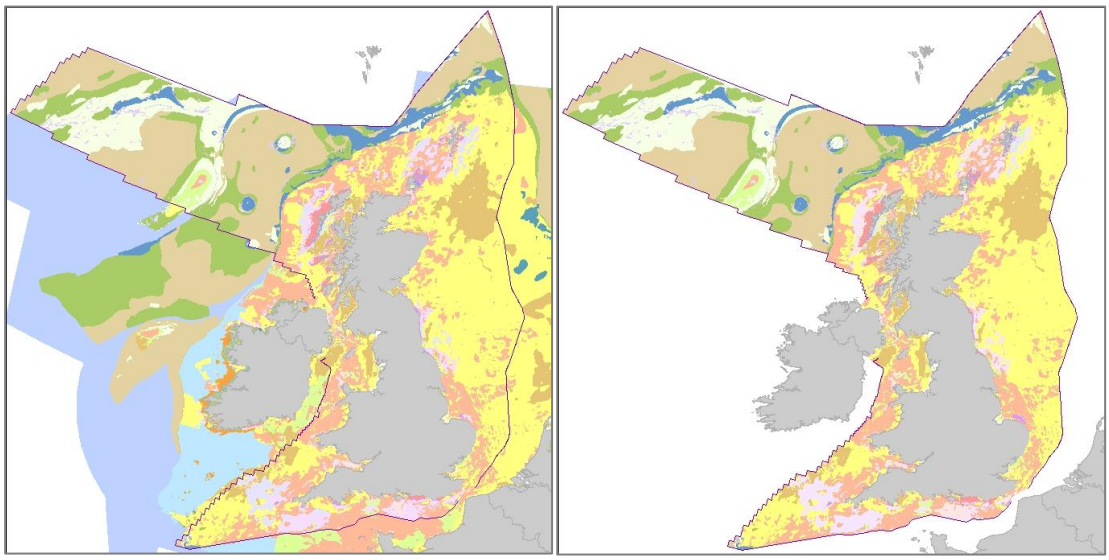

Figure D4: EUSeaMap (left) and UKSeaMap 2010 (right) predictive habitat maps; displayed at EUNIS level 3.

[22] http://jncc.defra.gov.uk/euseamap
[23] http://jncc.defra.gov.uk/ukseamap

Due to differences in their timelines, purpose and geographic coverage there are certain discrepancies that have arisen over the course of the projects, in the most part related to using best available data. These differences are summarised in Table D2.

EUSeaMap purpose: to provide a predictive broad-scale map of physical EUNIS habitats for around 2 million km^2 of European seas (Celtic, North, Baltic and western Mediterranean Seas) using a common approach to allow meaningful comparisons to be made across EU waters for use in the Marine Strategy Framework Directive, amongst other things.

UKSeaMap 2010 purpose: to provide a UK-wide predictive broad-scale map of physical EUNIS habitats and update the UKSeaMap 2006 coastal physiographic features layer, in time for use in the MCZ project, amongst other things.

Summary of differences between EUSeaMap and UKSeaMap 2010
The most recent predictive habitat map update for the UK seabed can be found in the latest version of EUSeaMap (autumn 2012). As detailed in **Error! Reference source not found.**, EUSeaMap contains some newer data and some of the same data as UKSeaMap 2010. However, UKSeaMap 2010 includes estuarine habitats, while EUSeaMap does not. In addition, there are differences in how the models assess confidence.

Future updates
The next phase of the EUSeaMap project (the Habitats theme under the EMODnet (European Marine Observation and Data Network) project) is due to begin in 2013 and last for three years. During this time the map will be improved in UK waters as a result of new data and improved methods. However in the short-term, JNCC plans to remove the confusion of publishing two similar but differing products by integrating the best aspects of both models into a single product. This is planned for the first half of 2013.

References

Cameron, A. and Askew, N. (Eds.). 2011. EUSeaMap - Preparatory Action for development and assessment of a European broad-scale seabed habitat map final report. Available from http://jncc.defra.gov.uk/euseamap [Accessed 11th March 2013]

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McBreen, F., Askew, N., Cameron, A., Connor, D., Ellwood, H. & Carter, A. 2011. UKSeaMap 2010: Predictive mapping of seabed habitats in UK waters. *JNCC Report*, No. 446. Available from: jncc.defra.gov.uk/ukseamap [Accessed 11th March 2013]

Table D2: Summary tables of differences between EUSeaMap and UKSeaMap 2010 in UK waters.

	EUSeaMap		UKSeaMap 2010	
	Classification	**Spatial resolution (WGS84)**	**Classification**	**Spatial resolution (WGS84)**
Final maps	Seabed types in EUNIS classification (levels 3 and 4)	0.003° *	Seabed types in EUNIS classification (levels 3 & 4) + additional layer showing coastal physiographic features	0.0025° *

* The differences in spatial resolution (cell size) reflect the differences in geographic coverage. In order for EUSeaMap to retain a similar minimum mapping unit across the regions (~300m), those at higher latitudes (Baltic, North and Celtic) took a reasonable average resolution of 0.003° to approximate a similar area per grid cell, whilst the western Mediterranean adopted a grid cell size of 0.0027°.

Model layer	**EUSeaMap (North and Celtic seas)**		**UKSeaMap 2010**		**Differences**	
	Classes	**Variable(s) used, source and resolution/scale**	**Classes**	**Variable(s) used, source and resolution/scale**	**Do they differ?**	**Why?**
Seabed substrata	**4 simplified Folk classes plus Rock**: • Mud to sandy mud • Sand to muddy sand • Mixed sediments • Coarse sediments • Rock	EMODnet Geology composite substrate map (same data source as UKSeaMap, but coarser resolution (1:1,000,000)). UKSeaMap 2010 substrate layer spliced in.	**4 simplified Folk classes plus Rock**: • Mud to sandy mud • Sand to muddy sand • Mixed sediments • Coarse sediments • Rock	DigSBS250 v2 (1:250k) pre release Improved regional rock layers (Defra contract MB0103 with BGS)	No	-
Biological zones	**Biological Zones (rock & sediment)** • Infralittoral • Circalittoral • Deep circalittoral • Deep-sea (following Howell, 2010)	**Light**: • MERIS on ENVISAT platform (250m coastal & 1km offshore) **Bathymetry**: • UK: Astrium 6 arcsecond (~0.0003°) DEM • Elsewhere: EMODnet	**Biological Zones (rock & sediment)** • Infralittoral • Circalittoral • Deep circalittoral • Deep-sea (following Howell, 2010)	**Light**: • AquaMODIS (4km) **Bathymetry**: • SeaZone 30m DEM • GEBCO (0.5')	Light: Yes Bathymetry: Yes	MERIS data, Atrium & EMODnet Hydrography DEMs arrived too late to be included in UKSM. Light threshold re-evaluated for EUSM using new

Model layer	EUSeaMap (North and Celtic seas)		UKSeaMap 2010		Differences	
	Classes	Variable(s) used, source and resolution/scale	Classes	Variable(s) used, source and resolution/scale	Do they differ?	Why?
		Hydrography DEM (0.25')				data and a GAM, resulting in a hard threshold of 4.5% as opposed to UKSM's 1%.
Energy	**Kinetic energy at the seabed (waves & tidal current)** High Medium Low	**Waves:** NOC ProWAM (~12.5km) and ABPMer bespoke coastal model based on DHI MIKE Spectral Wave (~100m) – Mean of annual maximums from 6 yr period. **Currents:** NOC CS20 (1.8km), CS3 (10km) and NEA (35km) tidal models – max for a single 'typical' year (2001) Previous studies (ABPmer, 2010) have shown this to be a reasonably average year for the majority of locations. (Produced under JNCC contract C10-0198-0316 by ABPMer/NOC)	**Kinetic energy at the seabed (waves & tidal current)** High Medium Low	**Waves:** NOC ProWAM (~12.5km) and ABPMer bespoke coastal model based on DHI MIKE Spectral Wave (~100m) – 1 in 5 year maximum **Currents:** NOC CS20 (1.8km), CS3 (10km) and NEA (35km) tidal models (produced under MB102 Task 2E)	Same raw data, but different stats used.	Waves: UKSM 1 in 5 yr max used to match UKSM 2006; EUSM put more resources into defining thresholds & came up with mean of annual maxs over 6 yr (however, more research needed).
Salinity	Not used	Continuous modelled salinity (DHI, ~5km) is used in the Baltic and Kattegat but resolution is too coarse to delineate estuarine areas of UK	Variable salinity	Variable salinity waters demarcated by WFD Typology maps	Yes	Variable/reduced salinity not mapped in EUSM – couldn't be done consistently across N Europe.

Annex E: Assessment and reporting of UK benthic habitats: a rationalised list (DRAFT)

Laura Robson, 15th March 2013

The UK has responsibilities under a number of different obligations to assess and report on the conservation status of its marine biodiversity. Each obligation has a defined list of benthic habitats to assess and report on. For the purposes of this exercise, these habitats are referred to as 'listed habitats'. These listed habitats include narrowly-defined habitat types, broadly defined habitat 'complexes' which are composed of other habitat sub-types, and more broadly defined and spatially wide ranging habitats known as 'broad-scale', or 'predominant' habitats. For MSFD, the indicative list of characteristics to be considered when defining GES (Annex III) includes two main benthic habitat types: 'Predominant' seabed habitats and 'Special' habitat types, which include those recognised or identified under Community legislation (Habitat Directive) or International conventions (e.g. OSPAR list of Threatened and/or Declining Species and Habitats)

The aim of this work was to generate a rationalised list of benthic habitats which represents the minimum number of habitats for which we require information to complete our assessment and reporting obligations in the UK. When the overlap between habitat definitions is taken into account, the number of 'unique' habitat types is reduced. The rationalised list was generated by considering the relationships between the listed habitats in terms of their component biotopes, removing any duplications or overlaps between habitat types on different lists, and identifying where aggregation of habitats could be used to streamline our assessment and reporting requirements.

The resultant rationalised list (Table E1) details 73 habitats where information is required to meet assessment and reporting requirements in the UK. The number of habitats has not reduced significantly from the original list of 94 habitats, due to the complex relationships between the listed habitats. In particular, the diversity of the Habitats Directive Annex I physiographic habitats is so great that it is difficult to define where they overlap with other listed habitats. Therefore the majority of these have been included on the rationalised list. Where listed habitats are not included on the rationalised list, the reason for their exclusion is detailed in Table E2.

The rationalised list is a **draft** piece of work and a complete report detailing the method used is currently in progress. This report will be available for review later this year, before being published on the JNCC website[24].

[24] Now available (as of 2014) here: http://jncc.defra.gov.uk/pdf/499%20_web_v2.pdf

Table E1: Rationalised list of habitats for marine assessment and reporting. Listed habitats are those listed under the EC Habitats Directive under Annex I (Annex I), the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR), the section 41, section 42 and Scottish biodiversity lists as Habitats of Principal Importance (HPI), the Ecological Network Guidance as Features of Conservation Importance (FOCI) and Broad-scale habitats (Broad-scale), the MSFD as Special habitats (MSFD Special) and Predominant habitats (Predominant) and the Scottish MPA Site Selection Guidelines as Search Features (SF) and Priority Marine Features (PMF).

NB – some listed habitats are considered sub-types of Annex I habitats. These have not been recorded in the priority habitat list column as being Annex I features since they are not specifically listed under Annex I.

Listed habitat	Component EUNIS biotopes (Aggregated to highest level)	Priority habitat list
Annual vegetation of drift lines	A2.511, A2.512, A2.531C	Annex I, MSFD Special
Atlantic salt meadows (*Glauco-puccinellietalia maritimae*)	A2.521, A2.531, A2.535, A2.536, A2.537, A2.538, A2.53A, A2.53B, A2.541, A2.542, A2.545, A2.546, A2.547, A2.548, A2.556, A2.557	Annex I, MSFD Special
Carbonate mounds	A6.75	OSPAR, PMF, SF, MSFD Special
Coastal (saline) lagoons	A3.34, A5.11, A5.21, A5.31, A5.41, A5.54	Annex I, FOCI, MSFD Special
Coastal saltmarsh	A2.5	HPI
Cold water coral reefs (*Lophelia pertusa* reefs)	A5.631, A6.611	OSPAR, MSFD Special, PMF
Coral gardens	A6.1, A6.2, A6.3, A6.4, A6.5, A6.7, A6.8, A6.9	OSPAR, FOCI, PMF, SF, MSFD Special
Deep-sea sponge aggregations	A6.62	OSPAR, FOCI, PMF, SF, MSFD Special
Estuaries	A1.32, A2.12, A2.2222, A2.31, A2.32, A2.41, A2.5, A3.36, A5.22, A5.32, A5.42	Annex I, MSFD Special
Estuarine rocky habitats	A1.32, A1.45, A2.431	HPI, FOCI
File/flame shell beds (*Limaria hians*)	A5.434	FOCI, PMF, SF
Fragile sponge and anthozoan communities on subtidal rocky habitats including northern seafan and sponge communities	A4.12, A4.131, A4.133, A4.211	HPI, FOCI, PMF, SF
Inshore deep mud with burrowing heart urchins (*Brissopsis lyriferai*)	A5.363	PMF, SF
Intertidal chalk and associated communities	A1.126, A1.2143, A1.441, B3.114, B3.115	OSPAR, HPI, FOCI, MSFD Special

Intertidal *Mytilus edulis* beds on mixed and sandy sediments	A2.7211, A2.7212	OSPAR, FOCI, MSFD Special
Mudflats and sandflats not covered by seawater at low tide	A2.2, A2.3, A2.4, A2.6, A2.85, A2.86	Annex I
Intertidal underboulder communities	A1.2142, A3.2112	HPI, FOCI
Kelp and seaweed communities on sublittoral sediment	A5.52	PMF, SF
Large Shallow Inlets and Bays	A1.15, A1.3, A2.24, A2.33, A2.42, A2.5, A3.22, A3.31, A3.32, A4.251, A5.341. A5.342, A5.343, A5.344, A5.5123, A5.5214, A5.522, A5.523, A5.524, A5.525, A5.526, A5.527, A5.528, A5.53, A5.613, A5.621, A5.623, A5.624	Annex I, MSFD Special
Maerl beds	A5.51	HPI, OSPAR, FOCI, PMF, SF, MSFD Special
Maerl or coarse shell gravel with burrowing sea cucumbers (*Neopentadactyla mixta*)	A5.144	PMF, SF
Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)	A2.513, A2.522, A2.523, A2.524, A2.525	Annex I, MSFD Special
M*odiolus modiolus* beds	A5.621, A5.622, A5.623, A5.624	OSPAR, HPI, FOCI, PMF, SF, MSFD Special
Mud habitats in deep water / offshore deep seas muds	A5.35, A5.36, A5.37, A5.7211, A6.5	HPI, FOCI, PMF, SF
Musculus discors beds	A4.242	HPI
Mytilus edulis beds	A2.212, A2.721, A5.625	OSPAR, HPI, FOCI, PMF, SF, MSFD Special
Offshore subtidal sands and gravels	A5.14, A5.15, A5.25, A5.26, A5.27, A5.44, A5.45, A6.2, A6.3, A6.4	PMF, SF
Ostrea edulis beds	A5.435	OSPAR, FOCI, PMF, SF, MSFD Special
Peat and clay exposures (with piddocks) (to include littoral and sublittoral)	A1.127, A1.223, A4.231	HPI, FOCI
Sabellaria alveolata reefs	A2.71, A5.611, A5.612	HPI, FOCI
Sabellaria spinulosa reefs	A4.22, A5.611	OSPAR, HPI, FOCI, MSFD Special
Salicornia and other annuals colonising mud and sand	A2.51B, A2.55, A2.551, A2.552, A2.553, A2.558	Annex I, MSFD Special
Sandbanks which are slightly covered by sea water all the time (≤20m water depth)	A5.11, A5.12, A5.13, A5.21, A5.22, A5.23, A5.24, A5.51	Annex I, MSFD Special
Seagrass beds / zostera beds	A2.61, A5.53, A5.545	OSPAR, HPI, FOCI, PMF, SF, MSFD Special
Sea loch egg wrack beds (*Ascophyllum nodosum)*	A1.325	PMF, SF

Seamounts (with associated communities)	A6.72	OSPAR, PMF, SF, MSFD Special
Seapen and burrowing megafauna communities / burrowed mud	A5.361, A5.362	OSPAR, PMF, SF, MSFD Special
Serpula vermicularis reefs	A5.613	PMF, SF, sub-type of Annex I Reef
Shallow tideswept coarse sands with burrowing bivalves	A5.133	PMF, SF
Spartina swards (*Spartinion maritimae)*	A2.554, A2.555	Annex I, MSFD Special
Submarine structures made by leaking gases (to include “bubbling reefs” and “pockmarks” made up of carbonate structures)	A5.711, A5.712	Annex I, MSFD Special
Submerged or partially submerged sea caves	A1.44, A3.71, A4.71	Annex I, MSFD Special
Subtidal chalk	A3.2113, A3.217, A4.23	HPI, FOCI
Subtidal mixed muddy sediments		HPI
Sheltered muddy gravels	A2.41, A2.42, A5.431, A5.432, A5.433, A5.435	HPI, FOCI
Tide-swept channels	A1.15, A3.212, A3.213, A3.22, A4.11, A4.25	HPI, FOCI
Tide-swept algal communities	A1.15, A3.126, A3.213, A3.22	SF, PMF
High energy intertidal rock	A1.1	Broad-scale
Moderate energy intertidal rock	A1.2	Broad-scale
Low energy intertidal rock	A1.3	Broad-scale
High energy infralittoral rock	A3.1	Broad-scale
Moderate energy infralittoral rock	A3.2	Broad-scale
Low energy infralittoral rock	A3.3	Broad-scale
High energy circalittoral rock	A4.1	Broad-scale
Moderate energy circalittoral rock	A4.2	Broad-scale
Low energy circalittoral rock	A4.3	Broad-scale
Intertidal coarse sediment	A2.1	Broad-scale
Intertidal mixed sediments	A2.4	Broad-scale
Shallow sublittoral coarse sediment	A5.1	MSFD Predominant
Shallow sublittoral mixed sediments	A5.4	MSFD Predominant
Shallow sublittoral sand	A5.2	MSFD Predominant
Shallow sublittoral mud	A5.3	MSFD Predominant

Shelf sublittoral coarse sediment	A5.1	MSFD Predominant
Shelf sublittoral mixed sediments	A5.4	MSFD Predominant
Shelf sublittoral sand	A5.2	MSFD Predominant
Shelf sublittoral mud	A5.3	MSFD Predominant
Subtidal macrophyte-dominated sediment	A5.5	Broad-scale
Upper bathyal sediment	A6	MSFD Predominant
Lower bathyal sediment	A6	MSFD Predominant
Upper bathyal rock and biogenic reef	A6	MSFD Predominant
Lower bathyal rock and biogenic reef	A6	MSFD Predominant
Abyssal sediment	A6	MSFD Predominant
Abyssal rock and biogenic reef	A6	MSFD Predominant

Table E2: Habitats excluded from the rationalised list for marine habitat assessment and reporting with reason for exclusion.

Listed habitat exclusion	Component EUNIS biotopes (Aggregated to highest level)	Priority habitat list	Reason for exclusion
Coastal saltmarshes and saline reedbeds	A2.5	Broad-scale	Duplicated by coastal saltmarsh
Cymodocea meadows	A5.531	OSPAR	Does not occur in UK waters
Intertidal mudflats	A2.3	OSPAR, UKBAP, PMF	Duplicated by mudflats and sandflats not covered by seawater at low tide
Low or variable salinity habitats	A3.32, A3.34, A3.36, A5.31	SF	Duplicated by estuaries, large shallow inlets and bays and coastal lagoons
Oceanic ridges with hydrothermal vents/fields	A6.94	OSPAR	Does not occur in UK waters
Reefs (Bedrock, stony and biogenic)	A1, A2.7, A2.83, A3, A4, A5.6, A6.1, A6.21, A6.23, A6.6, A6.7, A6.8, A6.9, B3.1, B3.11	Annex I	Duplicated by infralittoral rock, circalittoral rock and a number of other listed habitats (eg fragile sponge and anthozoan communities)
Subtidal sands and gravels	A5.1, A5.2	HPI, FOCI	Duplicated by shallow sublittoral coarse sediment, shelf sublittoral coarse sediment, shallow sublittoral sand and shelf sublittoral sand
Intertidal sand and muddy sand	A2.2	Broad-scale	Duplicated by mudflats and sandflats not covered by seawater at low tide

Intertidal mud	A2.3	Broad-scale	Duplicated by mudflats and sandflats not covered by seawater at low tide
Intertidal biogenic reefs	A2.7	Broad-scale	Duplicated by biogenic reef sub-types
Intertidal sediments dominated by aquatic angiosperms	A2.6	Broad-scale	Duplicated by mudflats and sandflats not covered by seawater at low tide
Littoral sediment	A2.1, A2.2, A2.3, A2.4, A2.5, A2.6	MSFD Predominant	Duplicated by intertidal coarse sediment and intertidal mixed sediments
Littoral rock and biogenic reef	A1.1, A1.2, A1.3, A2.7	MSFD Predominant	Duplicated by high energy, moderate energy and low energy intertidal rock, and biogenic reef sub-types
Shallow sublittoral rock and biogenic reef	A3.1, A3.2, A3.3, A4.1, A4.2, A4.3, A5.6	MSFD Predominant	Duplicated by high, moderate and low energy infralittoral rock, High, Moderate and Low energy circalittoral rock and biogenic reef sub-types
Shelf sublittoral rock and biogenic reef	A5.6	MSFD Predominant	Duplicated by high, moderate and low energy infralittoral rock, High, Moderate and Low energy circalittoral rock and biogenic reef sub-types
Subtidal biogenic reefs	A5.6	Broad-scale	Duplicated by biogenic reef sub-types
Subtidal coarse sediment	A5.1	Broad-scale	Duplicated by shallow sublittoral coarse sediment and shelf sublittoral coarse sediment
Subtidal sand	A5.2	Broad-scale	Duplicated by Shallow sublittoral sand and Shelf sublittoral sand
Subtidal mud	A5.3	Broad-scale	Duplicated by Shallow sublittoral mud and Shelf sublittoral mud
Subtidal mixed sediments	A5.4	Broad-scale	Duplicated by Shallow sublittoral mixed sediments and Shelf sublittoral mixed sediments
Deep-sea bed	A6	Broad-scale	Duplicated by Upper bathyal sediment, Lower bathyal sediment, Upper bathyal rock and biogenic reef, Lower bathyal rock and biogenic reef, Abyssal sediment and Abyssal rock and biogenic reef

Annex F: Discussion Points from the Workshop Sessions 2-4

Table F1: Notes and discussion points from Session 2

<table>
<tr><th colspan="2">SESSION 2: Can extent and distribution be defined for particular habitats/biotopes?</th></tr>
<tr><td colspan="2"><u>Outcomes</u>
Develop a series of recommendations on:
• whether/how extent and distribution can be defined for particular habitats/biotopes

By establishing:
• which habitats/biotopes are suitable for an indicator of extent/distribution
• what current mapping data are available to support these indicators
• the feasibility of indicators of extent/distribution for the suitable habitats/biotopes</td></tr>
<tr><td colspan="2"><u>Approach</u>
The attendees split into three subgroups in order to try and answer the three questions for this session on whether/how extent and distribution can be defined for particular habitats (see the workshop programme in Annex B for details of the three questions). Each group had a set of different habitats to work through taken from the rationalised list of habitats in order to answer these questions on a habitat by habitat basis. The more habitat specific comments can be found in the rationalised list template in Section 5 of this report. The more general comments are noted within this table for Session 2. The general comments include the approach used by each of the groups as to how they decided upon whether an extent/distribution indicator was suitable for a particular habitat and also comments that came out of the plenary session for Session 2.</td></tr>
<tr><td>GROUP 1: Approach</td><td><u>Group 1 took into consideration:</u>
– Temporal variability (habitats where variability is extreme are not suitable for extent/distribution indicators).
– Biological vs. physical (any habitat defined by the presence of an organism CAN have its extent changed by pressure but human pressures cannot impact at UK scale those habitats defined by physical parameters (predominant)). However, extent cannot feasibly be mapped for any habitat defined by infauna as it would rely too heavily on ground-truthing.
– Classification difficulties (for some habitats it is not feasible to measure extent due to the difficulties with the classification, e.g. it is not feasible to map extent of intertidal sand vs intertidal mixed sediments vs. intertidal mud (because from aerial photography the difference can't be mapped)).
– Ease of remote sensing detection.
– Prioritising condition indicators instead of extent/distribution indicators may be more important for some habitats.
– Only current and known impacts (clear and present danger) were taken into consideration.</td></tr>
</table>

GROUP 2: Approach	Group 2 took into consideration: – The differences between extent and distribution (considered them separately for each of the habitats). – Whether the extent of the habitat would be impacted by human pressures (at the current time) and identified what those pressures might be. Only currently occurring pressures were considered and where these are likely/able to occur at the moment. An assumption was made that the mapping of habitats and pressures is sufficient to overlay with the habitat type to be able to detect any potential impact. – Accessibility of certain habitat types (e.g. intertidal), concurrent with known impact/large scale human pressures and will lend themselves much more easily to monitoring. – Connectivity of certain habitat types (e.g. connectivity is potentially more important for *Mytilus edulis* than the overall distributional range and pattern). – Natural variability in the extent and range of certain habitat types (e.g. for *Mytilus* spp., presence/absence will change so much more naturally, that it might not be suitable to spend money monitoring and setting targets for something that changes more naturally). Indicators would be appropriate, but it might not actually be possible to measure any change in reality. – Spatially-based indicators of condition will be required for many of these habitat types.
GROUP 3: Approach	Group 3 took into consideration: – Whether the habitat could theoretically be affected or actually be affected (likelihood vs. possibility). – Ecological aspects, such as habitats with a large biological component and the ephemeral nature of some habitats were also taken into account. – In considering pressures impact on habitat extent, the following aspects were used to assess the feasibility to develop extent/distribution indicators: • the likelihood of pressures impacting on habitat extent, • the possibility of pressures impacting on habitat extent and • the significance of the impact
General comments from the Plenary session	– Any habitat defined by the presence of an organism CAN have its extent changed by pressure. However, for any habitat defined by infauna, its extent cannot feasibly be mapped. – Any habitat defined by its physical nature is not going to have its extent changed significantly by human pressures (e.g. broadscale habitats). – Substrate is more important for measures of extent and fauna is more important for measures of condition. – Issue with classification resolution – it is not appropriate to map intertidal mixed sediment based on their definition therefore it's more feasible to map extent at a sublittoral sediment level (i.e. higher up the hierarchy). – For some habitats, connectivity is more important than distribution (e.g. *Mytilus edulis*). – In some cases, extent more important (better indicator) for some habitats (e.g. mussel beds/maerl beds)) and in other cases, distribution is more important (e.g. subtidal/bathyal mud which often moves about). – For predominant habitats, extent/distribution indicators might be more appropriate at a sub habitat level. – Need to understand the levels of accuracies in your maps in order to be able to measure change in extent accurately.

Table F2: Notes and discussion points from Session 3

SESSION 3: How can we measure change in habitat extent and distribution indicators?	
Outcomes Develop a series of recommendations on: • how we can measure change in habitat extent/distribution indicators directly or indirectly By establishing: • whether/how we can measure change in habitat extent/distribution (e.g. measuring habitat loss) • what level of resolution/habitat classification is required for the analysis of habitat data • what potential R&D work is required for each relevant habitat to fully develop these indicators	
Approach The attendees split into the same subgroups as for Session 2 in order to try and answer the three questions for this session on how we can measure change in habitat extent and distribution indicators (see the workshop programme in Annex B for details on the three questions). Each group carried forward their list of habitats that they had already determined an extent and/or distribution indicator would be appropriate in order to answer these questions on per habitat basis. The habitat specific comments can be found in the rationalised list template in Section 5 of this report. A summary of the points from all of the groups is provided for each question and some of the more general comments from the plenary session are also outlined below.	
Question 1: *Whether/how we can measure change in habitat extent/distribution?*	– In order to measure change in habitat extent, at Time 1 establish extent by direct measurements (i.e. aerial and groundtruthing), and at Time 2 the change in extent will be obtained from measurement and/or consideration of the footprint of the appropriate pressure. To ensure this is feasible, we need to put in place a system through the licensing scheme to be able to track developments in real time (Group 1). – Standardisation is necessary in methodology (sampling and data interpretation) to allow us to detect real change in extent/distribution (Group 1). – Decent models will be relied upon to help detect change in extent and distribution for those habitats which cannot be directly monitored. However, these models will depend on the availability of good empirical evidence to construct reliable models (Group 2). – There will often be a requirement for both a direct and indirect approach to detecting change (i.e. model the predicted distribution of the habitat and then groundtruth the model predictions and target direct sampling to these areas) (Group 2). – What level of loss denotes change in GES for a feature? How detectable is this level of change? E.g. rock is not likely to change; however, for sponge on rock it is difficult to map extent and change in extent therefore perhaps it would be better to look at condition (Group 3). – Where condition indicators are more important than the overall extent/distribution of the habitat (e.g. for under boulder communities), you would still need to know the overall extent in order to put your change in condition into the context of the quantity of habitat that has been degraded (e.g. the proportion of the whole) (Group 2). – It is more realistic to target specific areas for monitoring using a risk-based approach rather than attempting to map the entire extent of a habitat (Group 3). – Repeat monitoring of certain habitats (e.g. Carbonate mounds) may not be cost effective or practical. An indirect approach could be used such as VMS data to give an indication of pressure (assuming that VMS data is useable and of sufficient resolution) (Group 3). – For *Sabellaria,* encounter frequency (or likelihood of encounter) is suggested as a potential metric for indirect measurement rather than 100% coverage (e.g. along a fixed monitoring transect) (Group 1).

Question 2: *What level of resolution / habitat classification is required?*	– Need a rule-based approach to allow comparison/consistency that will determine what spatial resolution is appropriate (fractals). The 'rule' must be linked to the size of error in methodology as well as what the indicator will be applied to (i.e. what is the scale of change you are interested in) so there is an expectation that a 'nested approach' might be best with different (but consistently defined) scales (e.g. UK scale vs. MPAs or areas of high risk scale vs. single reefs) (Group 1). – When using modelled habitat extent and overlaying pressures information to detect any kind of change in extent/distribution, indicators rely on quite accurate maps of the extent of these habitats (e.g. shallow sublittoral coarse sediments). If the accuracy of your map at that level of habitat classification is only +/- 30%, then detecting small changes due to pressures would be impossible with any confidence. You could group things at a higher level of classification to have higher confidence in the habitat mapping but is this meaningful? You may also need to consider which of the constituent biotopes are most sensitive to human pressures and attempt to map these instead of the predominant habitat type but is it even possible to map these smaller biotopes? (Group 2) – Plus, the delineation of coarse sediment from mixed sediment is extremely difficult with acoustic remote sensing and therefore we are very unlikely to be able to vastly increase the accuracy of the mapping with current techniques (possibility of using AUV and habitat mosaicing in future). It might make more sense to group the habitat at a higher level of classification to be more confident in detecting the change due to human pressures (Group 2).
Question 3: *What potential R&D work is required?*	– Identify the acoustic signature of a habitat and define what constitutes the boundary of the feature (oyster beds and Sabellaria) (Group 1). – Poor habitat definitions – improve? (Group 1) – Increase understanding of the impacts of activities (Group 3).
Plenary Session: General Comments	– There are developments in the WFD that could be applied to the MSFD. In Scotland, there is a system for capturing footprints of activities. – Consider satellite imagery to help measure change in extent for intertidal habitats. Natural Resources Wales (NRW) is looking into this for terrestrial habitats but it could theoretically be applied to coastal habitats. However, ensure to look into the resolution capabilities of satellite imagery. – At a workshop in Scotland, Fugro and Proteus talked about bathymetric LiDAR (getting info down to 20m in some areas). Particularly useful for Scotland where water clarity is better. Aerial monitoring working group under HBDSEG are already looking at this. – This workshop is looking mainly at what can be done now but would be worth looking at what work is coming up and what developments are happening in mapping so we have an idea of what will be possible in future. – Accessibility to industry data needs to be improved.

Table F3: Notes and discussion points from Session 4

SESSION 4: Baselines and reference conditions	
Outcomes Develop a series of recommendations on how baselines should be used for potential habitat extent/distribution indicators and suggestions for filling gaps in knowledge.	
Approach: The attendees split into the same subgroups as for Sessions 2 & 3 in order to try and answer the two questions for this session on baselines and reference conditions (see workshop programme in Annex C for details of the questions). Each group carried forward their list of habitats that they had already determined an extent/distribution indicator would be appropriate in order to answer these questions on a habitat by habitat basis. The more habitat specific comments can be found in the rationalised list template in Section 5 of this report. A summary of the points from all of the groups is provided for each question below.	
Question 1: *What baselines should we be using?*	– In principle the baseline for habitats should be aligned to the Habitats Directive. The Habitats Directive sets the baseline as the area existing at the inception of the Directive (1994). The target is to maintain or increase - this is a different model to the concept of a baseline of extent when no human impact existed (differences to MSFD approach) (Group 1). – The function of a baseline should be to allow you to set/detect a trend, not a target (Group 1). – It's difficult to separate baselines and targets (Group 2). – Historical reference conditions are useful for target setting (Group 3). – How do you define historical? Is it defined as any data already available or before impact? Difficulty in conceptual difference between historical data and historical reference condition. Is 5 yrs old data historical or just 'old'? (Group 1) – Use a risk-based approach to target specific areas to define baselines for rather than a baseline defined for the whole UK (Group 2). – May need to have different baselines for extent and distribution depending on feature type and whether historical data is available, e.g. for *Lopheilia* reefs, where historical data and a wider reference base can inform a wider distribution base, whereas extent would be based on current data and knowledge (Group 3).
Question 2: *How do you detect real change in extent over time compared to change due to improved methods of measurem-ent?*	– Detecting real change requires standardisation (like for like comparison) (Group 3). – When using historical baselines there needs to be calibration between methodologies if these have changed or a standardised method needs to be imposed and then applied to data from the past in a modelled form in order to detect real change (Group 1). – How do we deal with technological developments? (Group 3) – When we don't know how much information there is historically, we have to compare current with historical to see which of the two should be used as a baseline; the decision depends on confidence in the historical record and the proportion of habitat already lost (Group 1). – When variability in time is too large then a current baseline is preferable to a historical baseline (Group 1). – To measure extent, you often need modern data. To measure distribution, you can often make use of historic data/habitat suitability models (Group 3). – Frequency of monitoring and assessment (and adjustment of baseline/reference points) will vary between features, e.g. *Sabellaria* is likely to change year on year so frequent of monitoring is required, where as slow-growing features may not need frequent monitoring unless pressures are known to elevate risk to the integrity of the feature. The frequency of monitoring could also be based on a risk-based approach to target features most at risk (Group 3).